

Level 3 NVQs in Refrigeration and Air Conditioning (6187)

Qualification handbook for centres



www.cityandguilds.com
October 2017
Version 2.1

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Qualification title	Number	QAN
Level 3 NVQ Certificate in Installing and Commissioning Air Conditioning and Heat Pump Systems	6187-03	600/0900/7
Level 3 NVQ Certificate in Servicing and Maintaining Air Conditioning and Heat Pump Systems	6187-04	600/0909/3
Level 3 NVQ Certificate in Installing and Commissioning Refrigeration Systems	6187-05	600/0907/X
Level 3 NVQ Diploma in Servicing and Maintaining Refrigeration Systems	6187-06	600/0991/3

Version and date	Change detail	Section
2.0 July 2012	Optional Unit 330 added and ROC amended	1.1 Qualification structure 4.1 Summary of assessment methods 5. Units
2.1 October 2017	Added TQT and GLH details Deleted QCF	Qualification Structure Throughout

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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	City & Guilds qualification number	Qualification accreditation number	Registration and certification
Level 3 NVQ Certificate in Installing and Commissioning Air Conditioning and Heat Pump Systems	6187-03	600/0900/7	
Level 3 NVQ Certificate in Servicing and Maintaining Air Conditioning and Heat Pump Systems	6187-04	600/0909/3	See Walled Garden/ Online Catalogue for last dates
Level 3 NVQ Certificate in Installing and Commissioning Refrigeration Systems	6187-05	600/0907/X	
Level 3 NVQ Diploma in Servicing and Maintaining Refrigeration Systems	6187-06	600/0991/3	

1.1 Qualification structure

To achieve the **Level 3 NVQ Certificate in Installing and Commissioning Air Conditioning and Heat Pump Systems (6187-03)**, learners must achieve a total of **28** credits:

- **16** credits must come from the **3** 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				
R/602/2498	303	Understand how to organise resources within BSE	Online multiple choice	3
K/502/8913	304	Understand Halocarbon ‘fluorinated’ air conditioning and heat pump system installation and commissioning techniques	Online multiple choice	10
J/502/8918	305	Install and commission Halocarbon ‘fluorinated’ air conditioning and heat pump systems	Portfolio	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 **Level 3 NVQ Certificate in Servicing and Maintaining Air Conditioning and Heat Pump Systems (6187-04)**, learners must achieve a total of **34** credits:

- **22** credits must come from the **3** 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				
R/602/2498	303	Understand how to organise resources within BSE	Online multiple choice	3
T/502/8915	306	Understand Halocarbon 'fluorinated' air conditioning and heat pump systems service and maintenance techniques	Online multiple choice	16
F/502/8920	307	Service and maintain halocarbon 'fluorinated' air conditioning and heat pump systems	Portfolio	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 **Level 3 Certificate in Installing and Commissioning Refrigeration Systems (6187-05)**, learners must achieve a total of **34** credits:

- **22** credits must come from the **3** 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				
R/602/2498	303	Understand how to organise resources within BSE	Online multiple choice	3
Y/502/9300	308	Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques	Online multiple choice	16
M/502/9304	310	Install and commission Halocarbon 'fluorinated' refrigeration systems	Portfolio	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 **Level 3 NVQ Diploma in Servicing and Maintaining Refrigeration Systems (6187-06)**, learners must achieve a total of **37** credits:

- **25** credits must come from the **3** 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
R/602/2498	303	Understand how to organise resources within BSE	Online multiple choice	3
H/502/9302	309	Understand Halocarbon ‘fluorinated’ refrigeration system service and maintenance techniques	Online multiple choice	19
F/502/9307	311	Service and maintain Halocarbon ‘fluorinated’ refrigeration systems	Portfolio	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

1.2 Opportunities for progression

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

- 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
Level 3 NVQ Certificate in Servicing and Maintaining Air Conditioning and Heat Pump Systems	282	340
Level 3 NVQ Diploma in Servicing and Maintaining Refrigeration Systems	312	370

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 that are currently approved to offer the following qualifications

- 6087-03 Level 3 NVQ in refrigeration and air conditioning systems (Commercial and industrial air conditioning systems)
- 6087-04 Level 3 NVQ in refrigeration and air conditioning (Ammonia refrigeration systems)
- 6087-05 Level 3 NVQ in refrigeration and air conditioning (Commercial and industrial refrigeration systems – non ammonia)
- 6127-02 Level 3 Certificate in complex refrigeration and air conditioning systems

are eligible for automatic approval for the following qualifications

- 6187-03 Level 3 NVQ Certificate in Installing and Commissioning Air Conditioning and Heat Pump Systems
- 6187-04 Level 3 NVQ Certificate in Servicing and Maintaining Air Conditioning and Heat Pump Systems
- 6187-05 Level 3 NVQ Certificate in Installing and Commissioning Refrigeration Systems
- 6187-06 Level 3 NVQ Diploma in Servicing 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 (CPD)

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

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, and;
- 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.

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.

4 Assessment

4.1 Summary of assessment methods

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

Unit	Title	Assessment method	Where to obtain assessment materials
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
303	Understand how to organise resources within BSE	City & Guilds Online multiple choice test (6187-303)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
304	Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques	City & Guilds Online multiple choice test (6187-304)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
305	Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems	Portfolio (6187-305) 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
306	Understand Halocarbon 'fluorinated' air conditioning and heat pump system service and maintenance techniques	City & Guilds Online multiple choice test (6187-306)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.

307	Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems	Portfolio (6187-307) 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
308	Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques	City & Guilds Online multiple choice test (6187-308)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
309	Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques	City & Guilds Online multiple choice test (6187-309)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
310	Install and commission Halocarbon 'fluorinated' refrigeration systems	Portfolio (6187-310) 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
311	Service and maintain Halocarbon 'fluorinated' refrigeration systems	Portfolio (6187-311) 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
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 GOLLA 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 e.g. diagrams, drawings, specifications, customer testimony, authorised and 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 units for this qualification follow. The learning outcomes and assessment criteria are also viewable on the Register of Regulated Qualifications: register.ofqual.gov.uk

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)
- Learning outcomes which are comprised of a number of assessment criteria
- Recommended Guided Learning Hours (GLH)
- Endorsement by a sector or other appropriate body
- Information on assessment

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 to 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
 - Programmable/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 to buildings

Assessment criteria

The learner can:

- 7.1 Define the system layout features for electrical circuits in non dwelling and commercial properties
 - Ring main circuit
 - Radial circuit
 - Fixed equipment supplies
 - Spurs and fused outlets
- 7.2 Specify the types of cables and conductors used for installation of electrical equipment in mechanical services systems
- 7.3 State the applications and limitations of the types of cable and conductors used for the installation of electrical equipment in mechanical services systems
- 7.4 Clarify the difference between class 1 and class 2 electrical equipment
- 7.5 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
- 7.6 Define the operating principles of electrical circuit protection devices
 - Miniature circuit breakers
 - Residual current devices including RCBs
 - Fuses

- Re-wireable
- Cartridge
- High breaking capacity

7.7 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

7.8 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 303

Understand how to organise resources within BSE

Level: 3
Credit value: 3
UAN: R/602/2498

Learning outcomes

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

1. Know the responsibilities of relevant people in the building services industry
2. Know how to oversee building services work
3. Know how to produce risk assessments and method statements for the building services industry
4. Know how to plan work programmes for work tasks in the building services industry

Guided learning hours

It is recommended that **26** 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

This unit will be assessed by:

- An on-line test

Unit 303 Understand how to organise resources within BSE

Outcome 1 Know the responsibilities of relevant people in the building services industry

Assessment Criteria

The learner can:

- 1.1 Define the types of client that are encountered when working
 - Private customer
 - Direct communication
 - Through customer representatives - managing agents
 - Contracting customer
 - Internal customer – within same company
- 1.2 Specify the types of communication that may be required with clients throughout the progress of a job
- 1.3 Specify the types of communication that may be required with the site management team
 - Architect
 - Quantity surveyor
 - Buyer/Estimator
 - Surveyor
 - Project manager/Clerk of Works
 - Structural engineer
 - Building services engineer
 - Contracts manager
 - Construction manager
- 1.4 Define the typical site responsibilities for craft operatives in the workplace
 - Apprentices/trainees
 - Level 2 craft level qualified staff
 - Limited self responsibility
 - Level 3 craft level qualified staff
 - Supervision of self and other staff members
- 1.5 Specify the different methods of supervising individuals that can be used
 - Styles of supervision
 - Methods of motivating staff
- 1.6 Define the job responsibilities when supervising staff
 - Identifying the competence of subordinates to undertake work
 - Identifying when direct supervision or detailed direction is required
 - Specific health and safety issues
 - Responsibility for planning safe working for subordinates
 - How to adjust work schedules when health and safety problems delay works

Unit 303

Understand how to organise resources within BSE

Outcome 2

Know how to oversee building services work

Assessment Criteria

The learner can:

2.1 Specify how to deal with variations to works

- Prescribed by the work environment
 - Communication to the client
 - Agreement to extra time and costs
- Prescribed by the customer
 - Agreement to extra time and costs

2.2 Clarify how to undertake ongoing monitoring of the work progress against the work programme to ensure

- Safety
- Cost effectiveness
- Quality

2.3 Clarify how to deal with problems that arise with deficiencies in work performance that could affect

- Safety
- Cost effectiveness
- Quality

Unit 303

Understand how to organise resources within BSE

Outcome 3

Know how to produce risk assessments and method statements for the building services industry

Assessment Criteria

The learner can:

- 3.1 Define the levels of risk presented by work situations
- 3.2 Define the hazards presented by work situations
- 3.3 Specify the methods used to carry out a risk assessment for a task
 - Methods of assessing risk
 - Risk calculation formula
 - Presentation of a risk assessment
- 3.4 Identify how to produce a method statement for areas of work with safety risk
 - Information to be provided in a method statement
 - Presentation of a method statement

Unit 303

Understand how to organise resources within BSE

Outcome 4

Know how to plan work programmes for work tasks in the building services industry

Assessment Criteria

The learner can:

4.1 Specify the types of work programme that would be used for

- Private installation work
- Private service/maintenance work
- New-build installation contract work
- Service/maintenance contract work

4.2 State the process for planning work activities against job specifications

- The scope, purpose and requirements of the work
- Identification of work responsibilities
- External factors that affect timeframe

4.3 State the process for selecting the required resources against the job specification

- Materials
- Plant
- Vehicles
- Equipment

4.4 Specify material delivery requirements against work programmes and the impact that the non-availability of materials may have on work progress

- Work in private properties
- Work on new-build housing
- Work on commercial contracts
- Avoiding loss of materials on site (theft)

4.5 Define the factors which affect working time allocation to work activities

- Labour resources
- Planning work with other trades
- Material deliveries

4.6 Identify how to produce simple work programmes

- Simple bar (progress) charts

Unit 304

Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques

Level: 3
Credit value: 10
UAN: K/502/8913

Learning outcomes

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

1. Understand the working principles and layouts of Halocarbon (fluorinated) air conditioning and heat pump systems
2. Understand the legislative and organisational procedures for the installation and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
3. Understand the procedures for planning and preparing for the installation and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
4. Understand the procedures for installing Halocarbon (fluorinated) air conditioning and heat pump systems equipment and components
5. Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
6. Understand the decommissioning procedures for Halocarbon (fluorinated) air conditioning and heat pump systems

Guided learning hours

It is recommended that **90** 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

This unit will be assessed by:

- An on-line test

Unit 304

Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques

Outcome 1

Understand the working principles and layouts of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

1.1 Define the function and operating principles of:

- Compressors
- Condensers
- Expansion devices
 - Capillary tube
 - Thermostatic expansion valves
 - Electronic expansion valves
- Direct Expansion & Flooded Evaporators
- Accumulators
- 2 and 3 pipe variable refrigerant flow systems for cooling and heating
- Same mode systems
- Heat recovery systems
- Free cooling facility
- Oil recovery systems
- Defrosting systems
- Fan arrangements (propeller, centrifugal, axial)

1.2 Identify the features and characteristics of:

- Four way valves
- Critical charge systems
- Inverter systems
- Low ambient control systems
- Pipework insulation
- Air filters
- Condensate removal
- Refrigeration network and splitter joints
- BC boxes
- Solenoid valves
- Ducted units
- Wall mounted and above ceiling cassette units
- Fan arrangements (propeller, centrifugal, axial)

- 1.3 State the procedures for plotting and calculating quantities and capacities for each of the following:
- Sensible and latent processes
 - Humidification and dehumidification
 - Supply condition using:
 - Mixing fresh air/re-circulated air
 - Volume flow rates
- 1.4 Identify and calculate cooling and heating capacity in kW for individual fan coil or supply grille using system information and psychometric charts
- 1.5 Describe various environment conditions and explain how they may be maintained through application of air conditioning systems

Unit 304

Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques

Outcome 2

Understand the legislative and organisational procedures for the installation and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 2.1 State the appropriate sources of health and safety information which apply when installing and commissioning air conditioning and heat pump systems
- 2.2 State the regulations, codes of practice, and industry recommendations appropriate to installation and commissioning of air conditioning and heat pump systems,
- 2.3 Specify the procedures for carrying out risk assessments to ensure safe working with all pressurised and flammable fluids
- 2.4 State appropriate persons whom it may be necessary to advise before a system is isolated in order to undertake work
- 2.5 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
- 2.6 Specify the organisational procedures for reporting and agreeing changes and or variations to work plans
- 2.7 Identify client and employer requirements for procedures to be followed when work has been completed:
 - Tidy and clear site
 - Complete documentation (client and employers)
 - Communicate with customer and employer
 - Complete hazardous waste consignment documentation

Unit 304

Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques

Outcome 3

Understand the procedures for planning and preparing for the installation and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 3.1 Explain what information is required in order to plan installation and commissioning activities
- 3.2 Identify which people should be communicated with to enable planning and preparation
- 3.3 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
 - Condensate drainage and components
- 3.4 Specify the potential risk posed by Legionella in condensate areas
- 3.5 Specify planning considerations and procedures for replacing the refrigerant type in air conditioning and heat pump systems, including:
 - Evaluating the suitability of replacement refrigerant types for different systems
 - Requirements for safely disposing of refrigerant that is to be replaced
 - Procedures for re-commissioning
- 3.6 Define the measures required to protect the building fabric/customer property, before and throughout completion of installation and commissioning work, including:
 - Use of dust sheets
 - Protection from flame damage
 - Protection of customer/client
 - Protection of appliances and components
- 3.7 Specify procedures for conducting a visual inspection of the work site to determine requirements for:
 - Access
 - Structures
 - Storage of tools, equipment and materials
 - Co-ordination of work with others
 - Services
 - Electric
 - Drains
 - Water
- 3.8 Identify Personal Protective Equipment relevant to the installation and commissioning work activities

Unit 304

Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques

Outcome 4

Understand the procedures for installing Halocarbon (fluorinated) air conditioning and heat pump systems equipment and components

Assessment Criteria

The learner can:

- 4.1 Explain how to fit and fix pipework, equipment and components to a range of different backgrounds:
 - Brick
 - Block
 - Concrete
 - Timber studding
 - Plasterboard/wall board
 - Rolled Steel Joists and 'U' Channel
- 4.2 Describe the care and maintenance procedures required for tools and equipment to be used, including requirements for confirming that appropriate items of equipment are correctly calibrated
- 4.3 Specify the methods and procedures for completing the following pipework jointing techniques:
 - Brazing of similar and dissimilar metals
 - Flaring and alternative compression fittings
- 4.4 State the features and characteristics of different brackets used for securing air conditioning pipework, equipment and components
- 4.5 Specify other fixing methods for attaching indoor and outdoor units to:
 - Walls
 - Roofs
 - Ground
 - Ceiling voids
 - Risers

Unit 304

Understand Halocarbon 'fluorinated' air conditioning and heat pump system installation and commissioning techniques

Outcome 5

Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

5.1 State the methods and procedures for:

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

5.2 Specify the procedures for determining what type and quantity of refrigerant is required

5.3 Explain how to charge blended (zeotropic blends) and single fluid refrigerants into the system

5.4 Determine when charge is correct using system parameters

- Weight
- Running conditions
- Temperatures, pressures, current, air flow/volume

5.5 Specify the procedures for completing system records and commissioning documentation

5.6 Describe the process for handing over system to customer, including:

- Demonstrating operation of system controls
- Completing and passing on appropriate commissioning documentation

Unit 304

Understand Halocarbon ‘fluorinated’ air conditioning and heat pump system installation and commissioning techniques

Outcome 6

Understand the decommissioning procedures for Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 6.1 State the implications that the suspension of an air conditioning 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 system materials, including refrigerants and heavy/awkward items which require mechanical and manual handling
- 6.3 Specify the procedures for the safe recovery, recycling, reclaim and disposal of refrigerants
- 6.4 Identify work sequences for decommissioning and making safe a system by following industry procedures

Unit 305

Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Level: 3
Credit value: 3
UAN: J/502/8918

Learning outcomes

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

1. Be able to plan and prepare for the installation and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
2. Be able to carry out the installation of Halocarbon (fluorinated) air conditioning and heat pump systems
3. Be able to carry out the pre-commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
4. Be able to carry out the commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
5. Be able to handover Halocarbon (fluorinated) air conditioning and heat pump systems
6. Be able to carry out the de-commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Guided learning hours

It is recommended that **4** 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

This unit will be assessed by:

- Portfolio

Unit 305 Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 1 Be able to plan and prepare for the installation and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 1.1 Confirm that all information is available prior to planning installation or commissioning 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 commissioning 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 or any structural or access issues which need to be resolved prior to work commencement
- 1.6 Identify safe storage arrangements for tools, equipment and materials prior to commencement of installation or commissioning 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 for 2 or 3 pipe systems
 - Jointing by brazing or flaring of refnet/pipe splitters/BC boxes
 - Confirming requirements for:
 - Cleanliness inside pipes by purging with OFN
 - Insulation
 - Electrical connection
 - Condensate disposal

Unit 305 Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 2 Be able to carry out the installation of Halocarbon
(fluorinated) 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 pipework, systems and components, including:

- Regulatory documents
- Industry Codes of Practice
- Manufacturer's instructions
- Installation specification

2.2 Assemble 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 305

Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 3

Be able to carry out the pre-commissioning of Halocarbon (fluorinated) 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 the checks and tests in accordance with industry and safety requirements
- 3.3 Demonstrate procedures for replacing the refrigerant type in air conditioning and heat pump systems, including:
 - Selecting suitable replacement refrigerant types for different systems
 - Safely disposing of refrigerant that is to be replaced
 - Re-commissioning the system on completion of refrigerant replacement
- 3.4 Carry out the following tests in accordance with appropriate legislation:
 - Strength integrity test
 - Pressure tightness test
 - Leak test
 - Evacuation, dehydration and vacuum rise test
- 3.5 Compare pipework length with system factory charge and determine whether extra refrigerant charge is required
- 3.6 Add additional refrigerant charge by weight in accordance with manufacturer's instructions
- 3.7 Carry out basic electrical tests to confirm that system is safe to switch on:
 - Visual integrity check
 - Continuity
 - Insulation resistance
 - Polarity
 - Resistance to earth
- 3.8 Complete checks to confirm system is leak free

Unit 305

Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 4

Be able to carry out the commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 4.1 Confirm that the system provides cooling and/or heating by measuring air flow temperature difference across indoor and outdoor unit heat exchangers
- 4.2 Record temperature differences
- 4.3 Remove analysers/gauges from systems without refrigerant loss
- 4.4 Replace valve caps and confirm valves are leak free

Unit 305 Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 5 Be able to handover Halocarbon (fluorinated) 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
 - 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 line manager that installation is complete and fill in appropriate company documentation

Unit 305

Install and commission Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 6

Be able to carry out the de-commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

6.1 Produce appropriate risk assessments and method statements to ensure decommissioning activities can be completed safely

6.2 Demonstrate work sequences for permanently decommissioning:

- A complete Halocarbon (fluorinated) air conditioning or heat pump system
- Part of a Halocarbon (fluorinated) air conditioning or heat pump system

6.3 Demonstrate how oil and refrigerant could be safely recovered from a system and disposed of

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Level:	3
Credit value:	16
UAN:	T/502/8915

Learning outcomes

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

1. Understand the working principles and layouts of Halocarbon (fluorinated) air conditioning and heat pump systems
2. Understand the legislative and organisational procedures for the service and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems
3. Understand the procedures for planning and preparing for the servicing and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems
4. Understand the service and maintenance procedures for Halocarbon (fluorinated) air conditioning and heat pump systems
5. Understand the procedures for identifying and rectifying faults on Halocarbon (fluorinated) air conditioning and heat pump systems
6. Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
7. Understand the decommissioning procedures for Halocarbon (fluorinated) air conditioning and heat pump systems

Guided learning hours

It is recommended that **150** 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

This unit will be assessed by:

- An on-line test

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 1

Understand the working principles and layouts of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

1.1 Define the function and operating principles of:

- Compressors
- Condensers
- Expansion devices
 - Capillary tube
 - Thermostatic expansion valves
 - Electronic expansion valves
- Direct Expansion & Flooded Evaporators
- Accumulators
- 2 and 3 pipe variable refrigerant flow systems for cooling and heating
- Same mode systems
- Heat recovery systems
- Free cooling facility
- Oil recovery systems
- Defrosting systems
- Fan arrangements (propeller, centrifugal, axial)

1.2 Identify the features and characteristics of:

- Four way valves
- Critical charge systems
- Inverter systems
- Low ambient control systems
- Pipework insulation
- Air filters
- Condensate removal
- Refrigeration network and splitter joints
- BC boxes
- Solenoid valves
- Ducted units
- Wall mounted and above ceiling cassette units
- Fans

- 1.3 State the procedures for plotting and calculating quantities and capacities for each of the following:
- Sensible and latent processes
 - Humidification and dehumidification
 - Supply condition using:
 - Mixing fresh air/re-circulated air
 - Volume flow rates
- 1.4 Identify and calculate cooling and heating capacity in kW for individual fan coil or supply grille using system information and psychometric charts
- 1.5 Describe various environment conditions and explain how they may be maintained through application of air conditioning and heat pump systems

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 2

Understand the legislative and organisational procedures for the service and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 2.1 State the appropriate sources of health and safety information which apply when servicing and maintaining air conditioning and heat pump systems
- 2.2 State the regulations, codes of practice, and industry recommendations appropriate to servicing and maintenance of air conditioning and heat pump systems
- 2.3 Specify the procedures for carrying out risk assessments to ensure safe working with all pressurised and flammable fluids
- 2.4 State appropriate persons whom it may be necessary to advise before an air conditioning or heat pump system is isolated in order to undertake work
- 2.5 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
- 2.6 Specify the organisational procedures for reporting and agreeing changes and or variations to work plans
- 2.7 Identify client and employer requirements for procedures to be followed when work has been completed:
 - Tidy and clear site
 - Complete documentation (client and employers)
 - Communicate with customer and employer
 - Complete hazardous waste consignment documentation

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 3

Understand the procedures for planning and preparing for the servicing and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 3.1 Describe the range of information that is required in order to plan and complete servicing and maintenance activities
- 3.2 Identify which people should be communicated with to enable planning and preparation
- 3.3 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
 - Condensate drainage and components
- 3.4 Specify the potential risk posed by Legionella in condensate areas
- 3.5 Specify planning considerations and procedures for replacing the refrigerant type in air conditioning and heat pump systems, including:
 - Evaluating the suitability of replacement refrigerant types for different systems
 - Requirements for safely disposing of refrigerant that is to be replaced
 - Procedures for re-commissioning
- 3.6 Define the measures required to protect the building fabric/customer property, before and throughout completion of servicing and maintenance work, including:
 - Use of dust sheets
 - Protection from flame damage
 - Protection of customer/client
 - Protection of appliances and components
- 3.7 Specify procedures for conducting a visual inspection of the work site to determine requirements for:
 - Access
 - Structures
 - Storage of tools, equipment and materials
 - Co-ordination of work with others
 - Services
 - Electric
 - Drains
 - Water
- 3.8 Identify Personal Protective Equipment relevant to the servicing and maintenance work activities
- 3.9 Specify the procedures for organising and requisitioning the materials, tools and equipment required for the completion of servicing and maintenance work activities

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 4

Understand the service and maintenance procedures for Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

4.1 Understand the service and maintenance procedures for Halocarbon (fluorinated) air conditioning and heat pump systems

4.2 State the requirements for routine preventative maintenance including:

- Maintaining system refrigerating efficiency
- Main system component overhaul
- To reduce indirect emissions of greenhouse gases
- Maintain system integrity to reduce direct emissions of greenhouse gases

4.3 Explain the effects that the following can have on system efficiency :

- Reduced cooling fluid flow on various condensers
- Reduced fluid flow on various evaporators
- Refrigerant leakage
- Incorrect compressor suction superheat
- Compressor low volumetric efficiency
- Mechanical wear in compressor
- Reduced refrigerant feed to evaporators
- Excessive refrigerant feed to evaporators

4.4 Explain the methods for ensuring that the correct control settings are adopted for the following in order to maintain system efficiency:

- Thermostats
- High pressure cut outs
- Low pressure cut outs
- Multi-function electronic controls covering defrost, temperature control, fan speed etc
- Control units (remote and hardwired)
- Time clocks
- BMS (building management systems)

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

- Compressor failure to start
- Condenser
- Evaporator
- Reversing (four way) valve
- Undercharge/overcharge
- Electrical control circuit
- Electronic boards
- Freezing of indoor/outdoor unit

- Noise and vibration
- Condensate leakage and contamination
- Fan motors
- Solenoid valves
- Linear electronic valves
- Poor fluid flow through heat exchangers

4.6 State the requirements for completing records and reports on the servicing and maintenance of air conditioning and heat pump systems

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 5

Understand the procedures for identifying and rectifying faults on Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

5.1 Interpret information on air conditioning and heat pump component faults from:

- Advice from users
- Visual inspections or tests
- Diagnostic tests

5.2 Identify the procedures for isolating mains supplies to air conditioning or heat pump components in accordance with industry recommendations for:

- Refrigerant gases
- Water services
- Electrical

5.3 Explain the work actions and sequences for diagnosing faults in refrigeration systems and components and consider:

- Fault diagnostics without the use of instruments using eyes, touch, hearing and smell
- Component operation and characteristics
- The influence of the system upon system operation
- The function and setting of controls and safety equipment

5.4 Specify the work actions and sequences for rectifying faults in systems and components which will ensure minimum disruption to customers/clients and the work environment

5.5 State the fitting and fixing procedures for the replacement of high and low pressure air conditioning and heat pump equipment and components

5.6 State the actions to be taken when an air conditioning or heat pump system or component cannot be restored to full performance

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 6

Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

6.1 State the methods and procedures for:

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

6.2 Specify the procedures for determining what type and quantity of refrigerant is required

6.3 Explain how to charge blended and single fluid refrigerant substances into various systems including water chillers

6.4 Determine when refrigerant charge is correct using system parameters

- Weight
- Running conditions
- Temperatures, pressures, current, air flow/volume
- Energy efficiency ratio

6.5 Describe the correct starting procedures for:

- Controls
- Fans/motors

6.6 Specify the commissioning methods for the main air conditioning and heat pump system components, including:

- System controls
- Component controllers
- Evaporative condensers
- Air and water cooled condensers
- Cooling towers
- Screw compressors
- Reciprocating compressors
- Centrifugal compressors including oil free
- Scroll compressors
- Automatic leak detection systems

6.7 Specify the procedures for completing system records and commissioning documentation

6.8 Describe the process for handing over systems to customers/clients, including:

- Demonstrating operation of system controls
- Completing and passing on appropriate commissioning documentation

Unit 306

Understand Halocarbon 'fluorinated' air conditioning and heat pump service and maintenance techniques

Outcome 7

Understand the decommissioning procedures for Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 7.1 State the implications that the suspension of an air conditioning or heat pump system can have on other person(s), including:
 - Customers/clients
 - Other site workers
 - Site visitors
- 7.2 Identify the safe procedures for handling potentially hazardous system materials, including refrigerants and heavy/awkward items which require mechanical and manual handling
- 7.3 Specify the procedures for the safe recovery, recycling, reclaim and disposal of refrigerants
- 7.4 Identify work sequences for decommissioning and making safe an air conditioning or heat pump system following industry procedures
- 7.5 State the procedures required to prevent the inadvertent operation of a decommissioned system

Unit 307

Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems

Level: 3
Credit value: 3
UAN: F/502/8920

Learning outcomes

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

1. Be able to plan and prepare for the servicing and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems
2. Be able to carry out the maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems
3. Be able to identify and rectify faults in Halocarbon (fluorinated) air conditioning and heat pump systems
4. Be able to carry out the commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems
5. Be able to handover Halocarbon (fluorinated) air conditioning and heat pump systems
6. Be able to carry out the de-commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Guided learning hours

It is recommended that **4** 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

This unit will be assessed by:

- Portfolio

Unit 307 Service and maintain Halocarbon ‘fluorinated’ air conditioning and heat pump systems

Outcome 1 Be able to plan and prepare for the servicing and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 1.1 Confirm that all information is available prior to planning service 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 service 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 or any structural or access issues which need to be resolved prior to work commencement
- 1.6 Identify safe storage arrangements for tools, equipment and materials prior to commencement of service 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 for system service and maintenance activities, to include consideration of:
 - Location
 - Function
 - Areas served
 - Records
 - Labelling

Unit 307

Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 2

Be able to carry out the maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

- 2.1 Identify appropriate sources of information which impact upon the servicing and maintenance of Halocarbon (fluorinated) air conditioning and heat pump systems, including:
 - Regulatory documents
 - Industry Codes of Practice
 - Manufacturer's instructions
 - Maintenance and service schedules
- 2.2 Interpret maintenance schedules to identify required work activities
- 2.3 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
- 2.4 Check system operating conditions against control settings
- 2.5 Measure on/off temperatures to check comfort conditions in respect of temperature and humidity in the controlled space
- 2.6 Reconnect or re-install system components after maintenance and then carry out the following checks and tests before running the system:
 - Tightness testing
 - Evacuation and dehydration
 - Electrical testing
- 2.7 Demonstrate procedures for replacing the refrigerant type in air conditioning and heat pump systems, including:
 - Selecting suitable replacement refrigerant types for different systems
 - Safely disposing of refrigerant that is to be replaced
 - Re-commissioning the system on completion of refrigerant replacement
- 2.8 Re-charge refrigerant to correct quantity and check for leakage
- 2.9 Complete system performance test
- 2.10 Complete appropriate maintenance documentation and records

Unit 307

Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 3

Be able to identify and rectify faults in Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

3.1 Diagnose, confirm and rectify common faults, including those associated with:

- Reduced air flow to condensers
- Reduced air flow to evaporators
- Refrigerant leakage
- Condensate leakage
- Compressor failure
- Fan failure
- Blocked filters or driers
- Incorrect refrigerant charge

3.2 Diagnose, confirm and rectify common electrical faults, including those associated with:

- Compressor motor failure
- Faulty connections
- Poor earth connections
- Control circuit failure
- Fan motor failure
- Condensate pump failure

Unit 307

Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 4

Be able to carry out the commissioning of Halocarbon (fluorinated) air conditioning and heat pump systems

Assessment Criteria

The learner can:

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

Unit 307

Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 5

Be able to handover Halocarbon (fluorinated) 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
 - 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 line manager that servicing or maintenance work is complete and fill in appropriate company documentation

Unit 307

Service and maintain Halocarbon 'fluorinated' air conditioning and heat pump systems

Outcome 6

Be able to carry out the de-commissioning of Halocarbon (fluorinated) 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 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Level: 3
Credit value: 16
UAN: Y/502/9300

Learning outcomes

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

1. Understand the working principles and layouts of Halocarbon (fluorinated) refrigeration systems, equipment and components
2. Understand the operating principles and characteristics of controls used for Halocarbon (fluorinated) refrigeration systems
3. Understand the design principles which apply for the arrangement of Halocarbon (fluorinated) refrigeration systems
4. Understand the legislative and organisational procedures for the installation and commissioning of Halocarbon (fluorinated) refrigeration systems
5. Understand the procedures for planning and preparing for the installation and commissioning of Halocarbon (fluorinated) refrigeration systems
6. Understand the procedures for installing Halocarbon (fluorinated) refrigeration systems, equipment and components
7. Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) refrigeration systems
8. Understand the decommissioning procedures for Halocarbon (fluorinated) refrigeration systems

Guided learning hours

It is recommended that **150** 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

This unit will be assessed by:

- An on-line test

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 1

Understand the working principles and layouts of Halocarbon (fluorinated) refrigeration systems, equipment and components

Assessment Criteria

The learner can:

- 1.1 Define the function and operating principles for the following refrigeration system arrangements:
 - Vapour compression systems
 - Secondary systems using brines, glycol and ethyl alcohols
 - Compound system arrangements
 - Multi-temperature systems
 - Cascade system arrangements
- 1.2 Identify the functions and uses of the following items of specialist equipment and components associated with the refrigeration system arrangements outlined in 1.1:
 - Open and closed flash intercoolers
 - Cascade condensers
 - Expansion vessels
 - 'Pack' arrangements and oil return
 - Bursting discs and relief valves
 - Refrigerant pumps and liquid overfeed systems
 - Surge drums
 - Suction accumulators
- 1.3 Specify the ways that compressors can be used in refrigeration systems and identify capacity control methods for the following types of compressor:
 - Screw
 - Reciprocating
 - Screw and reciprocating booster compressors in low temperatures applications
 - Centrifugal including oil free
 - Scroll
- 1.4 State the properties of Primary and Secondary refrigerants with regard to suitability for high, low and ultra-low temperature operation
- 1.5 Specify the procedures for plotting vapour compression cycles on pressure/enthalpy charts for:
 - Compound installations
 - Cascade arrangements
 - Multi-evaporation temperatures with one stage of compression

1.6 Identify and calculate values for :

- Refrigeration capacity
- Total power required
- Mass flow rates for high and low stages of compression
- Condenser capacity
- Dryness fraction
- Specific volume at suction
- Pressure ratios
- Temperature split
- Heat energy available for heat reclaim purposes

1.7 State the methods for using psychometric charts for refrigeration purposes

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 2

Understand the operating principles and characteristics of controls used for Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

2.1 State the operating principles for controls relating to:

- Temperature variables
- Pressure variables
- Liquid variables

2.2 Define the function and operating principles for the following pressure regulating valves fitted to multiple evaporator systems:

- Direct acting
- Pilot operated
- Externally compensated

2.3 Explain methods for modulating capacity in:

- Condensers
- Evaporators
- Cooling Towers
- Evaporative condensers

2.4 Specify the controls, control sequence of operation and the electrical circuit requirements for safe defrost operation of Cold Stores operating below a store temperature of 1°C

2.5 State the control requirements for multi-evaporator defrosting arrangements which employ the use or combination of:

- Hot gas
- Cold gas
- Electric

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 3

Understand the design principles which apply for the arrangement of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

3.1 Identify criteria for designing cold stores, including:

- Product specific heat capacity
- Electrical load of components
- Material and fabric quality (u value rating)
- Construction methods for cold rooms

3.2 Calculate cold store operational parameters including:

- Heat gain for various product loads
- Power consumption from main components
- Energy Efficiency Ratio
- Total cold store power consumption
- Annual maintenance cost

3.3 State the causes of and problems associated with 'frost heave'

3.4 Explain how problem areas in the cold store envelope develop as a result of:

- Rain water
- Condensation
- Inadequate ventilation

3.5 Specify under floor heating methods and controls used in the design of cold stores, including:

- Electric
- Glycol circulation
- Air circulation

3.6 Identify requirements for door positioning in cold stores:

- Externally located with solar gains
- Internally located with surrounding ambient temperatures

3.7 Specify heat recovery arrangements for Halocarbon and fluorinated refrigerant gas refrigeration systems, including heat source requirements relating to:

- Temperature level
- Magnitude of energy rate
- The timing of availability and need

3.8 Describe potential heat recovery arrangements which relate to the use of:

- Under floor heating
- Space heating in winter
- Reheat coils for humidity control
- Hot water services
- Heating swimming pools in leisure centres

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 4

Understand the legislative and organisational procedures for the installation and commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 4.1 State the appropriate sources of health and safety information which apply when installing and commissioning refrigeration systems
- 4.2 State the regulations, codes of practice, and industry recommendations appropriate to installation and commissioning of refrigeration systems
- 4.3 Specify the procedures for carrying out risk assessments to ensure safe working with all pressurised and flammable fluids
- 4.4 State appropriate persons whom it may be necessary to advise before a refrigeration system is isolated in order to undertake work
- 4.5 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
- 4.6 Specify the organisational procedures for reporting and agreeing changes and or variations to work plans
- 4.7 Identify client and employer requirements for procedures to be followed when work has been completed:
 - Tidy and clear site
 - Complete documentation (client and employers)
 - Arrange suitable system evaluation and inspection points throughout the year
 - Complete hazardous waste consignment documentation
 - Complete refrigerant usage records

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 5

Understand the procedures for planning and preparing for the installation and commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

5.1 Explain what information is required in order to plan installation and commissioning activities

5.2 Identify which people should be communicated with to enable planning and preparation

5.3 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
- Condensate drainage and components

5.4 Specify the potential risk posed by Legionella in condensate areas

5.5 Specify planning considerations and procedures for replacing the refrigerant type in air conditioning and heat pump systems, including:

- Evaluating the suitability of replacement refrigerant types for different systems
- Requirements for safely disposing of refrigerant that is to be replaced
- Procedures for re-commissioning

5.6 Define the measures required to protect the building fabric/customer property, before and throughout completion of installation and commissioning work, including:

- Use of dust sheets
- Protection from flame damage
- Protection of customer/client
- Protection of appliances and components

5.7 Specify procedures for conducting a preliminary site survey with regard to:

- Establishing a suitable position for major components
- Locating all necessary services to ensure they are available such as- electric, drains, water
- Planning pipe runs
- Planning equipment foundations
- Measuring access points for large refrigeration plant
- Plant room requirements
- Roof loading requirements
- Noise levels
- Occupancy
- Safety

5.8 Identify Personal Protective Equipment relevant to the installation and commissioning work activities

5.9 Specify the procedures for organising and requisitioning the materials, tools and equipment required for the completion of installation and commissioning work activities

5.10 Identify the supervision, planning and administration needs for a refrigeration project, including:

- Planning programmes of work
- Scheduling deliveries
- Charting progress
- Need for communication/liasing with other relevant persons/trades
- Maintaining cash flow
- Factors which may result in delays
- Contingency planning

5.11 State the requirements for organising:

- Resources
- Safe site storage of materials, tools and equipment
- Delivery of materials

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 6

Understand the procedures for installing Halocarbon (fluorinated) refrigeration systems, equipment and components

Assessment Criteria

The learner can:

- 6.1 Explain how to fit and fix pipework, equipment and components to a range of different backgrounds:
 - Brick
 - Block
 - Concrete
 - Timber studding
 - Plasterboard/wall board
 - Rolled steel joists and 'U' channel
- 6.2 Describe the care and maintenance procedures required for tools and equipment to be used, including requirements for confirming that appropriate items of equipment are correctly calibrated
- 6.3 Specify the methods and procedures for completing the following pipework jointing techniques:
 - Brazing similar and dissimilar metals
 - Flaring and alternative compression fittings
- 6.4 State the features and characteristics of different brackets used for securing refrigeration pipework, equipment and components
- 6.5 Specify other fixing methods for attaching indoor and outdoor units to:
 - Walls
 - Roofs
 - Ground
 - Ceiling voids
 - Risers
 - Rolled steel joists and 'U' channel

Unit 308

Understand Halocarbon 'fluorinated' refrigeration system installation and commissioning techniques

Outcome 7

Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

7.1 State the methods and procedures for:

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

7.2 State the requirements for system commissioning in terms of :

- Testing
- Adjusting
- Balancing
- Training of operating and maintenance personnel

7.3 Specify the procedures for determining what type and quantity of refrigerant is required

7.4 Explain how to charge blended (zeotropic blends) and single fluid refrigerant substances into the system

7.5 Determine when charge is correct using system parameters

- Weight
- Running conditions
- Temperatures, pressures, current, air flow/volume

7.6 Describe the correct starting procedures for:

- Controls
- Fan and compressor motors
- Defrosting

7.7 Specify the commissioning methods for the main refrigeration system components, including:

- Cooling Towers
- Evaporative condensers
- Water cooled condenser
- Air Cooled condensers

7.8 State the commissioning methods for varieties of:

- Screw compressors
- Reciprocating compressors
- Rotary vane compressors
- Centrifugal compressors
- Scroll compressors

7.9 Specify the commissioning methods for cold stores, including requirements for:

- Under floor heating arrangements
- Jointing and sealing
- Door furniture
- Drains
- Bringing store floor down to operating temperature
- Lighting
- Defrost

7.10 Specify the procedures for completing system records and commissioning documentation

7.11 Describe the process for handing over system to customer, including:

- Demonstrating operation of system controls
- Completing and passing on appropriate commissioning documentation

Unit 308 Understand Halocarbon ‘fluorinated’ refrigeration system installation and commissioning techniques

Outcome 8 Understand the decommissioning procedures for
Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 8.1 State the implications that the suspension of a refrigeration system can have on other person(s), including:
 - Customers/clients
 - Other site workers
 - Site visitors
- 8.2 Identify the safe procedures for handling potentially hazardous system materials, including refrigerants and heavy/awkward items which require mechanical and manual handling
- 8.3 Specify the procedures for the safe recovery, recycling, reclaim and disposal of refrigerants
- 8.4 Identify work sequences for decommissioning and making safe a refrigeration system following industry procedures

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Level: 3
Credit value: 19
UAN: H/502/9302

Learning outcomes

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

1. Understand the working principles and layouts of Halocarbon (fluorinated) refrigeration systems, equipment and components
2. Understand the operating principles and characteristics of controls used for Halocarbon (fluorinated) refrigeration systems
3. Understand the design principles which apply for the arrangement of Halocarbon (fluorinated) refrigeration systems
4. Understand the legislative and organisational procedures for the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems
5. Understand the procedures for planning and preparing for the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems
6. Understand the service and maintenance procedures for Halocarbon (fluorinated) refrigeration systems
7. Understand the procedures for identifying and rectifying faults on Halocarbon (fluorinated) refrigeration systems
8. Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) refrigeration systems
9. Understand the decommissioning procedures for Halocarbon (fluorinated) refrigeration systems

Guided learning hours

It is recommended that **180** 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

This unit will be assessed by:

- An on-line test

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 1

Understand the working principles and layouts of Halocarbon (fluorinated) refrigeration systems, equipment and components

Assessment Criteria

The learner can:

1.1 Define the function and operating principles of:

- Compound system arrangements
- Cascade system arrangements
- Multi-temperature systems
- Secondary systems using brines, glycol and ethyl alcohols
- Vapour compression heat pumps

1.2 Identify the functions and uses of the following items of specialist equipment associated with the refrigeration systems arrangements outlined in 1.1:

- Open and closed flash intercoolers
- Cascade condensers
- Expansion tanks
- 'Pack' arrangements and oil return
- Reversing valves
- Refrigerant pumps and liquid overfeed systems
- Surge drums

1.3 State the function and operating principles of :

- Reciprocating compressors
- Mono and Twin Helical screw compressors
- Scroll compressors
- Centrifugal compressors
- Multivane rotary compressors
- Oil free compressors

1.4 Define the function and operating principles of :

- Air and water cooled condensers
- Cooling towers
- Evaporative condensers

1.5 State the function and operating principles of flooded and direct expansion evaporators

1.6 Describe the function and operating principles for the following expansion devices:

- Capillary tube
- Low and High pressure float
- Thermostatic expansion valve
- Electronic expansion valve

1.7 Define the function and operating principles for :

- Intercoolers
- Liquid accumulators
- Sub-coolers
- Oil recovery systems
- Heat recovery
- Centrifugal pumps

1.8 Describe the functions and operating principles of the following defrost arrangements :

- Reverse cycle
- Hot gas
- Cold gas
- Electric
- Combinations of the above

1.9 Explain the functions and operating principles for capacity control in refrigeration systems which use :

- Two or more reciprocating compressors
- Twin Helical screw compressor(s)
- Mono screw compressor
- Centrifugal compressor(s)
- Scroll compressor(s)

Unit 309 Understand Halocarbon ‘fluorinated’ refrigeration system service and maintenance techniques

Outcome 2 Understand the operating principles and characteristics of controls used for Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

2.1 State the operating principles for controls relating to:

- Temperature variables
- Pressure variables
- Liquid variables

2.2 Define the function and operating principles for the following pressure regulating valves fitted to multiple evaporator systems:

- Direct acting
- Pilot operated
- Externally compensated

2.3 Explain methods for modulating capacity in:

- Condensers
- Evaporators
- Cooling Towers
- Evaporative condensers

2.4 State the uses and limitations of solenoid valves used in refrigeration systems

2.5 Describe the performance requirements for the following vapour compression systems controls:

- High and Low system pressure cut out
- Oil differential pressure cut out
- Crankcase heater
- Flow switches
- Termination devices
- Compressor starting arrangements
- Pressure relief valves

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 3

Understand the design principles which apply for the arrangement of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 3.1 Describe the controls, control operating sequence and the electrical circuit requirements for the safe defrost operation of Cold Stores operating below a store temperature of 1°C
- 3.2 Specify the control requirements for underfloor heating arrangements with:
 - Fluid circulation e.g. ethylene glycol
 - Electric heater mats
- 3.3 State the properties of Primary and Secondary refrigerants with regard to suitability for high, low and ultra-low temperature operation
- 3.4 Specify the procedures for plotting vapour compression cycles on pressure/enthalpy charts for:
 - Compound installations
 - Cascade arrangements
 - Multi-evaporation temperatures with one stage of compression
- 3.5 State the procedures to calculate values for :
 - Refrigeration capacity
 - Total power required
 - Mass flow rates for high and low stages of compression
 - Condenser capacity
 - Heat energy available for heat reclaim purposes
 - Dryness fraction
 - Specific volume at suction
 - Compression ratios
 - Temperature split
 - Coefficient of performance
 - Superheat regions
 - Sub cooling
 - Energy Efficiency Ratio
- 3.6 Specify methods for using Psychometric charts for dehumidification purposes in relation to:
 - Stock protection in warehouses, munitions and archival storage
 - Condensation control in housing, swimming pools etc.
 - Process drying; such as timber, malt and chemicals
- 3.7 State the procedures for plotting data on the Psychometric charts to help prevent condensation on wall surfaces separating frozen and chilled storage rooms
- 3.8 Identify food storage physical data and storage conditions
- 3.9 Specify suitable conditions for the efficient operation of refrigeration plant

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 4

Understand the legislative and organisational procedures for the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 4.1 State the appropriate sources of health and safety information which apply when servicing and maintaining refrigeration systems
- 4.2 State the regulations, codes of practice, and industry recommendations appropriate to servicing and maintenance of refrigeration systems
- 4.3 Specify the procedures for carrying out risk assessments to ensure safe working with all pressurised and flammable fluids
- 4.4 State appropriate persons whom it may be necessary to advise before a refrigeration system is isolated in order to undertake work
- 4.5 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
- 4.6 Specify the organisational procedures for reporting and agreeing changes and or variations to work plans
- 4.7 Identify client and employer requirements for procedures to be followed when work has been completed:
 - Tidy and clear site
 - Complete documentation (client and employers)
 - Arrange suitable system evaluation and inspection points throughout the year
 - Complete hazardous waste consignment documentation

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 5

Understand the procedures for planning and preparing for the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

5.1 Explain what information is required in order to plan servicing and maintenance activities for the following:

- Systems:
 - Compound
 - Cascade
 - Secondary fluid
 - Cold Stores for chilled and frozen storage
 - Controls and system controllers
- Equipment:
 - Multiple evaporators equipped with hot gas defrost arrangements
 - Refrigeration Heat Pumps
 - Multiple compressors
- Condensing equipment:
 - Cooling towers
 - Evaporative condensers
 - Water cooled condensers
 - Multi – air cooled condensers
 - Condensing units

5.2 Identify which people should be communicated with to enable planning and preparation

5.3 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
- Condensate drainage systems

5.4 Specify the potential risk posed by Legionella in condensate areas

5.5 Specify planning considerations and procedures for replacing the refrigerant type in air conditioning and heat pump systems, including:

- Evaluating the suitability of replacement refrigerant types for different systems
- Requirements for safely disposing of refrigerant that is to be replaced
- Procedures for re-commissioning

5.6 Define the measures required to protect the building fabric/customer property, before and throughout completion of servicing and maintenance work, including:

- Use of dust sheets
- Protection from flame (heat) damage
- Protection of customer/client
- Protection of appliances and components

- 5.7 Identify Personal Protective Equipment relevant to the servicing and maintenance work activities
- 5.8 Specify the procedures for organising and requisitioning the materials, tools and equipment required for the completion of servicing and maintenance work activities
- 5.9 Identify the supervision, planning and administration needs for a refrigeration project, including:
- Planning programmes of work
 - Scheduling deliveries
 - Charting progress
 - Need for communication/liasing with other relevant persons/trades
 - Maintaining cash flow
 - Realising profit margin
 - Factors which may result in delays
 - Contingency and disaster recovery planning
- 5.10 Identify site requirements for:
- Equipment
 - Materials
 - Access
 - Structures
 - Storage
 - Services – electrical, drainage, water

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 6

Understand the service and maintenance procedures for Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

6.1 Explain the requirements for regular maintenance planning with regard to:

- Daily inspections
- Monthly inspections
- Annual and periodic compliance inspections

6.2 State the requirements for routine preventative maintenance including:

- Maintaining system refrigerating efficiency
- Main system component overhaul
- To reduce indirect emissions of greenhouse gases
- Maintain system integrity to reduce direct emissions of greenhouse gases

6.3 Explain the effects that the following can have on system efficiency:

- Reduced cooling fluid flow on various condensers
- Reduced fluid flow on various evaporators
- Refrigerant leakage
- Incorrect compressor suction superheat
- Compressor low volumetric efficiency
- Mechanical wear in compressor
- Reduced refrigerant feed to evaporators
- Excessive refrigerant feed to evaporators

6.4 Explain the methods for ensuring that the correct control settings are adopted for the following in order to maintain system efficiency:

- Thermostats
- High pressure cut outs
- Low pressure cut outs
- Multi-function electronic controls covering defrost, temperature control, fan speed etc
- Control units (remote and hardwired)
- Time clocks
- BMS (building management systems)
- Constant pressure valves

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

- Compressor failure to start
- Condenser
- Evaporator
- Reversing (four way) valve
- Undercharge/overcharge
- Electrical control circuit
- Electronic boards
- Freezing of indoor unit
- Noise and vibration
- Condensate leakage and contamination
- Fan motors
- Solenoid valves
- Linear electronic valves
- Poor fluid flow through heat exchangers
- Inefficient defrost

6.6 State the requirements for completing records and reports on the servicing and maintenance of refrigeration systems

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 7

Understand the procedures for identifying and rectifying faults on Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

7.1 Interpret information on refrigeration system component faults from:

- Advice from users
- Visual inspections or tests
- Diagnostic tests

7.2 Identify the procedures for isolating mains supplies to refrigeration system components in accordance with industry recommendations for:

- Refrigerant gases
- Water services
- Electrical

7.3 Explain the work actions and sequences for diagnosing faults in refrigeration systems and components and consider:

- Fault diagnostics without the use of instruments using eyes, touch, hearing and smell
- Component operation and characteristics
- The influence of the system upon system operation
- The function and setting of controls and safety equipment

7.4 Specify the work actions and sequences for rectifying faults in systems and components which will ensure minimum disruption to customers/clients and the work environment

7.5 State the fitting and fixing procedures for the replacement of high and low pressure refrigeration system equipment and components

7.6 State the actions to be taken when a refrigeration system or component cannot be restored to full performance

Unit 309

Understand Halocarbon 'fluorinated' refrigeration system service and maintenance techniques

Outcome 8 Understand the procedures for the completion of pre-commissioning and commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 8.1 State the methods and procedures for:
 - Strength integrity testing
 - Tightness testing
 - Leak testing
 - Evacuation and dehydration
- 8.2 Specify the procedures for determining what type and quantity of refrigerant is required
- 8.3 Explain how to charge blended (zeotropic blends) and single fluid refrigerant substances into various refrigeration systems
- 8.4 Determine when charge is correct using system parameters
 - Weight
 - Running conditions
 - Temperatures, pressures, current, air flow/volume
 - Energy efficiency ratio
- 8.5 Describe the correct starting procedures for:
 - Controls
 - Fans/motors
 - Defrosting
- 8.6 Specify the commissioning methods for the main refrigeration system components, including:
 - Cooling towers
 - Evaporative condensers
 - Water cooled condenser
 - Air cooled condensers
- 8.7 State the commissioning methods for compressors:
 - Screw compressors
 - Reciprocating compressors
 - Rotary vane compressors
 - Centrifugal compressors including oil free
 - Scroll compressors
 - Automatic leak detection systems

8.8 Specify the commissioning methods for cold stores, including requirements for:

- Under floor heating arrangements
- Jointing and sealing
- Door furniture
- Drainage
- Achieving cold store floor operating temperature
- Lighting
- Defrost

8.9 Specify the procedures for completing system records and commissioning documentation

8.10 Describe the process for handing over systems to customers/clients, including:

- Demonstrating operation of system controls
- Completing and passing on appropriate commissioning documentation

Unit 309 Understand Halocarbon ‘fluorinated’ refrigeration system service and maintenance techniques

Outcome 9 Understand the decommissioning procedures for
Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 9.1 State the implications that the suspension of a refrigeration system can have on other person(s), including:
 - Customers/clients
 - Other site workers
 - Site visitors
- 9.2 Identify the safe procedures for handling potentially hazardous system materials, including refrigerants and heavy/awkward items which require mechanical and manual handling
- 9.3 Specify the procedures for the safe recovery, recycling, reclaim and disposal of refrigerants
- 9.4 Identify work sequences for decommissioning and making safe a refrigeration system following industry procedures
- 9.5 State the procedures required to prevent the inadvertent operation of a decommissioned refrigeration system

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Level: 3
Credit value: 3
UAN: M/502/9304

Learning outcomes

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

1. Be able to plan and prepare for the installation and commissioning of Halocarbon (fluorinated) refrigeration systems
2. Be able to carry out the installation of Halocarbon (fluorinated) refrigeration systems
3. Be able to carry out the pre-commissioning of Halocarbon (fluorinated) refrigeration systems
4. Be able to carry out the commissioning of Halocarbon (fluorinated) refrigeration systems
5. Be able to handover Halocarbon (fluorinated) refrigeration systems
6. Be able to carry out the de-commissioning of Halocarbon (fluorinated) refrigeration systems

Guided learning hours

It is recommended that **4** 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

This unit will be assessed by:

- Portfolio

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Outcome 1

Be able to plan and prepare for the installation and commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 1.1 Confirm that all information is available prior to planning installation or commissioning 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 commissioning 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 or any structural or access issues which need to be resolved prior to work commencement
- 1.6 Identify safe storage arrangements for tools, equipment and materials prior to commencement of installation or commissioning activity
- 1.7 Plan safe access to work areas and confirm with responsible person on site
- 1.8 Confirm the site arrangements for:
 - Security
 - Fire precaution and control
- 1.9 Complete preparatory work as necessary in relation to location, siting and fixing of cold stores, including:
 - Insulated panels
 - Steel framework – internal or external arrangements
 - Piping
 - Jointing by brazing or flaring
 - Confirming requirements for:
 - Cleanliness inside pipes by purging with OFN
 - Insulation
 - Electrical supply
 - Condensate disposal
 - Positioning of condensing unit
 - Positioning of evaporator
 - Control arrangements
- 1.10 Complete preparatory work as necessary in relation to the location, siting and fixing of the following frost heave arrangements:
 - Electric heater mats
 - Glycol circulation
 - Air circulation

1.11 Confirm the installation requirements in respect of location, siting and fixing of vapour compression systems other than one stage of compression and/or more than one evaporator coil:

- Compound systems
- Cascade systems
- Compressor 'Pack' arrangements
- Multi- temperature systems

1.12 Confirm the installation requirements in respect of location, siting and fixing of:

- Secondary systems
- Cooling Towers
- Evaporative coolers
- Water cooled condensers

1.13 Confirm the installation requirements in respect of location, siting and fixing of vapour compression systems using:

- Screw compressors
- Centrifugal compressors
- Rotary compressors
- Scroll compressors

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Outcome 2

Be able to carry out the installation of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

2.1 Identify and interpret appropriate sources of information which impact upon the installation of refrigeration pipework, systems and components, including:

- Regulatory documents
- Industry Codes of Practice
- Manufacturer's instructions
- Installation specification

2.2 Demonstrate appropriate methods for positioning and fixing:

- Underfloor heating arrangements, to include laying -
 - Glycol heating pipe circuit or electric heater mats
 - Insulation floor slabs
 - Vapour barriers
- Condensate drains
- Pipework and pipe insulation
- Internal racking
- Pressure, temperature and flow controls
- Insulation floor slabs
- Vapour barriers

2.3 Confirm that contraction joints are fixed correctly in position within the floor slab as required

2.4 Erect steel frameworks required for refrigeration systems

2.5 Position and fix slip sheet and supervise the laying of the appropriate floor slab

2.6 Complete the sealing junction locations, including:

- Roof and wall
- Floor and wall

2.7 Complete the interconnection and fixing of electrical power and communication components

2.8 Confirm that installed system components and pipework are correctly installed in accordance with the installation specification

2.9 Confirm that the worksite has been cleared in preparation for system testing

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Outcome 3

Be able to carry out the pre-commissioning of Halocarbon (fluorinated) 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 pre-commissioning

3.2 Identify placement of components to design drawings

3.3 Carry out the following pre-commissioning checks and tests in accordance with industry and safety requirements:

- Preliminary checks, including -
 - Unit inspection
 - Confirmation of: Plant details, unit nameplate details and compressor details
- Pre-start check list, consisting of -
 - Heat exchanger checks
 - Mechanical check list
 - Electrical check list
 - User connections
 - Power supply tests
 - Crankcase heaters
 - Pressure regulators
 - Oil heater options
 - Transformer voltage checks
 - Electronic controller, software, configuration etc
- Visual inspection of installation; checking -
 - Component serial numbers
 - Piping circuits
 - Controls to design specifications
 - Refrigerant distributors
 - Oil levels
 - Pumps

3.4 Demonstrate procedures for replacing the refrigerant type in refrigeration systems, including:

- Selecting suitable replacement refrigerant types for different systems
- Safely disposing of refrigerant that is to be replaced
- Re-commissioning the system on completion of refrigerant replacement

3.5 Carry out the following tests in accordance with appropriate legislation:

- Strength integrity test
- Pressure tightness test
- Leak test
- Evacuation, dehydration and vacuum rise test

3.6 Charge plant with correct refrigerant

3.7 Carry out basic electrical tests to confirm that system is safe to switch on:

- Visual integrity check
- Continuity
- Insulation resistance
- Polarity
- Resistance to earth

3.8 Open service valves, run plant and:

- Check for correct rotation of all fans
- Check control operation and adjust as necessary to required design settings
- Check defrost system
- Leak tests system
- Check air circulation in storage areas

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Outcome 4

Be able to carry out the commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

4.1 Confirm that the system provides refrigeration

4.2 Complete compressor start and safety device tests

4.3 Record operating conditions on the appropriate log sheet for:

- Evaporators
- Condensers
- Cooling Towers
- Evaporative condensers
- Liquid refrigerant pumps

and auxiliary components as required by specialist refrigeration systems such as:

- Compound intercooling arrangements
- Cascade condenser(s)
- Brine chiller(s)

4.4 Check defrost initiation and termination where fitted

4.5 Check capacity control operation for:

- Screw compressors
- Reciprocating compressors
- Centrifugal compressors
- Rotary compressors
- Scroll compressors
- Checks all machinery guards and warning notices are in place

4.6 Remove analysers/gauges from systems without refrigerant loss

4.7 Replace valve caps and confirm valves are leak free

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Outcome 5

Be able to handover Halocarbon (fluorinated) 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
- Compressor starter tests
- Safety device tests
- System refrigerant charge and type
- Performance testing
- Control settings
- Electrical testing

5.2 Complete refrigeration system records including:

- Operational log sheet
- Running current log sheet

5.3 Demonstrate system operation and operating controls to customer

5.4 Pass over system documentation and records to customer

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

Unit 310

Install and commission Halocarbon 'fluorinated' refrigeration systems

Outcome 6

Be able to carry out the de-commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

6.1 Produce appropriate risk assessments and method statements to ensure decommissioning activities can be completed safely

6.2 Demonstrate work sequences for permanently decommissioning:

- A complete Halocarbon (fluorinated) refrigeration system
- Part of a Halocarbon (fluorinated) refrigeration system

6.3 Demonstrate how oil and refrigerant could be safely recovered from a system and disposed of

Unit 311

Service and maintain Halocarbon 'fluorinated' refrigeration systems

Level: 3
Credit value: 3
UAN: F/502/9307

Learning outcomes

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

1. Be able to plan and prepare for the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems
2. Be able to carry out the maintenance of Halocarbon (fluorinated) refrigeration systems
3. Be able to identify and rectify faults in Halocarbon (fluorinated) refrigeration systems
4. Be able to carry out the commissioning of Halocarbon (fluorinated) refrigeration systems
5. Be able to handover Halocarbon (fluorinated) refrigeration systems
6. Be able to carry out the de-commissioning of Halocarbon (fluorinated) refrigeration systems

Guided learning hours

It is recommended that **4** 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

This unit will be assessed by:

- Portfolio

Unit 311 Service and maintain Halocarbon ‘fluorinated’ refrigeration systems

Outcome 1 Be able to plan and prepare for the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 1.1 Confirm that all information is available prior to planning service 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 service 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 or any structural or access issues which need to be resolved prior to work commencement
- 1.6 Identify safe storage arrangements for tools, equipment and materials prior to commencement of service 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 for system service and maintenance activities, to include consideration of :
 - Location
 - Function
 - Cooling loads served
 - Record
 - Labelling

Unit 311

Service and maintain Halocarbon 'fluorinated' refrigeration systems

Outcome 2

Be able to carry out the maintenance of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 2.1 Identify appropriate sources of information which impact upon the servicing and maintenance of Halocarbon (fluorinated) refrigeration systems, including:
 - Regulatory documents
 - Industry Codes of Practice
 - Manufacturer's instructions
 - Maintenance and service schedules
- 2.2 Interpret maintenance schedules to identify required work activities
- 2.3 Perform the following service and maintenance tasks safely and efficiently:
 - Cleaning and checking the condition of -
 - Condensers (including fans)
 - Filters
 - Indoor units
 - Evaporators (including fans)
 - Checking the condition of -
 - Pipework and its insulation
 - Electrical wiring, fuses and connections
 - Checking -
 - Water cooled condenser flow rate
 - Air flow rate through condenser and evaporator
 - Oil compressor charge
 - Operation of all safety devices
 - Condition and operation of all compression drives
- 2.4 Check system operating conditions against control settings
- 2.5 Measure humidity and temperature in the controlled space
- 2.6 Reconnect or re-install system components after maintenance and then carry out the following checks and tests before running the system:
 - Tightness testing
 - Evacuation and dehydration
 - Electrical testing
- 2.7 Demonstrate procedures for replacing the refrigerant type in refrigeration systems, including:
 - Selecting suitable replacement refrigerant types for different systems
 - Safely disposing of refrigerant that is to be replaced
 - Re-commissioning the system on completion of refrigerant replacement
- 2.8 Re-charge refrigerant to correct quantity and check for leakage
- 2.9 Complete system performance test
- 2.10 Complete appropriate maintenance documentation and records

Unit 311 Service and maintain Halocarbon ‘fluorinated’ refrigeration systems

Outcome 3 Be able to identify and rectify faults in Halocarbon
(fluorinated) refrigeration systems

Assessment Criteria

The learner can:

3.1 Diagnose common faults associated with:

- Compressors
- Condensers
- Suction and discharge
- Compressor oil supply
- Refrigerant supply
- Metering
- Electrical connections/supply

3.2 Rectify common faults associated with:

- Compressors
- Condensers
- Suction and discharge
- Compressor oil supply
- Refrigerant supply
- Metering
- Electrical connections/supply

Unit 311 Service and maintain Halocarbon ‘fluorinated’ refrigeration systems

Outcome 4 Be able to carry out the commissioning of Halocarbon (fluorinated) refrigeration systems

Assessment Criteria

The learner can:

- 4.1 Revisit risk assessment and safe working procedure to confirm currency and validity prior to commencement of testing
- 4.2 Carry out the checks and tests in accordance with industry and safety requirements, including:
 - Checking -
 - Safety mechanisms
 - Emergency procedures
 - Insulated structure for heat leakage (use of thermographic testing techniques)
 - The performance of the refrigeration system
 - The electrical energy consumption of the plant
 - Defrost system controls and operation
 - Sediment levels in brine tanks
 - Filters (and cleaning)
 - Pumping arrangements for noise, vibration, rotary shaft seals, stuffing boxes
 - Inspecting -
 - Condenser coils and fans
 - Evaporators and fans
 - Pressure relief valves
 - Condensate drains
 - Testing specific gravity of secondary refrigerant
- 4.3 Carry out the following tests in accordance with appropriate legislation:
 - Strength integrity test
 - Leak test
 - Pressure tightness test
 - Evacuation, dehydration and vacuum rise test
- 4.4 Compare pipework length with system factory charge and determine whether extra refrigerant charge is required
- 4.5 Add additional refrigerant charge by weight in accordance with manufacturer’s instructions
- 4.6 Carry out basic electrical tests to confirm that system is safe to switch on:
 - Visual integrity check
 - Continuity
 - Insulation resistance
 - Polarity
 - Resistance to earth
- 4.7 Open system valves and run system
- 4.8 Complete checks to confirm system is leak free
- 4.9 Confirm that the system provides cooling and/or heating by measuring air flow temperature difference across indoor and outdoor unit heat exchangers

- 4.10 Record temperature differences
- 4.11 Remove analysers/gauges from systems without refrigerant loss
- 4.12 Replace valve caps and confirm valves are leak free

Unit 311 Service and maintain Halocarbon ‘fluorinated’ refrigeration systems

Outcome 5 Be able to handover Halocarbon (fluorinated)
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 line manager that servicing or maintenance work is complete and fill in appropriate company documentation

Unit 311 Service and maintain Halocarbon ‘fluorinated’ refrigeration systems

Outcome 6 Be able to carry out the de-commissioning of Halocarbon (fluorinated) refrigeration 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 Halocarbon (fluorinated) refrigeration system
 - Part of a Halocarbon (fluorinated) 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 330/630 Understand and carry out electrical work on RAC systems and components

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

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.

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

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

Learning outcomes

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

12. Know the electrical standards that apply to the mechanical services industry
13. Know the inspection and testing requirements of electrically operated mechanical services components
14. Be able to inspect and test electrically operated mechanical services components
15. Know the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components
16. Be able to apply the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components
17. Know the fundamental principles of electrical supply to mechanical services and components
18. Know the features of electrical circuits and components in buildings
19. Understand the principles, regulatory requirements and procedures for completing the safe isolation of an electrical circuit
20. Be able to apply the principles, regulatory requirements and procedures for completing the safe isolation of an electrical circuit
21. 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
22. 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:

- 1.3 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
- 1.4 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:

- 2.8 Specify the requirements of a visual inspection of completed electrical installation work for mechanical services systems, prior to electrical inspection and testing
- 2.9 Define the equipment used for electrical testing of mechanical services components and its calibration requirements
- 2.10 Identify the importance of carrying out tests on dead circuits wherever possible
- 2.11 Interpret meter readings to inform decisions to be made in reference to safety and functionality of systems and components
- 2.12 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
- 2.13 Clarify the requirements for carrying out functional testing of electrical components
- 2.14 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:

- 3.4 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.
- 3.5 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
- 3.6 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:

- 4.9 State the methods of obtaining details of system faults from end users
- 4.10 Identify and use manufacturer instructions and industry standards to establish the diagnostic requirements of electrical system components
- 4.11 Identify the electrical test equipment used to undertake fault diagnostics
- 4.12 State the appropriate test equipment scales for the range of electrical tests
- 4.13 Identify the situations in which dead testing of components can be carried out
- 4.14 Identify the situations in which live testing of components may be necessary and the safety precautions required
- 4.15 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.
- 4.16 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:

- 5.4 Safely isolate electrical systems or components to prevent them being brought into operation before the work has been fully completed
- 5.5 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
- 5.6 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:

- 6.2 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:

- 7.10 Describe the potential hazards of working with or near electrical supply systems:
 - Electrical shock
 - Fire
 - Water
- 7.11 Define the operating principles of electrical circuit protection devices:
 - miniature circuit breakers
 - residual current devices including RCBO's
 - fuses:
 - rewireable
 - cartridge
 - high breaking capacity
- 7.12 Define types of electrical circuits in buildings:
 - Ring main
 - Radial
 - Spurs and fused-spur outlets
- 7.13 State conductor identification requirements in accordance with the current edition of BS7671
- 7.14 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
- 7.15 Clarify the difference between class 1 and class 2 electrical equipment
- 7.16 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

7.17 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

7.18 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:

- 8.4 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
- 8.5 State the implications of carrying out safe isolations to:
- Other personnel
 - Customers/clients
 - Public
 - Building systems (loss of supply)
- 8.6 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:

- 9.2 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:

- 10.10 Identify the preparatory work required to be carried out in order to install, commission, decommission or maintain electrical systems or components for mechanical services
- 10.11 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
- 10.12 Identify the hand and power tools required to complete work on electrical systems
- 10.13 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
- 10.14 State the factors which effect the selection of cables and conductors:
 - length
 - load
 - ambient temperatures
 - grouping of cables
 - protective device
 - insulation
- 10.15 Identify the cable, materials and fittings required to complete work on electrical systems
- 10.16 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

10.17 Define the application and limitations of cable termination methods:

- Screw terminals
- Pillar terminals
- Claw and washer terminals
- Crimping
- Strip connectors

10.18 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:

- 11.7 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
- 11.8 Wear personal protective equipment relevant to the installation, decommissioning, servicing or maintenance tasks being carried out
- 11.9 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
- 11.10 Apply temporary continuity bonding to metallic pipework prior to making pipework connections.
- 11.11 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
- 11.12 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.

Appendix 1 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 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the Centres and Training Providers homepage on www.cityandguilds.com.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve ‘approved centre’ status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Centre Manual - Supporting Customer Excellence contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve ‘approved centre’ status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents such as:

- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

Access to Assessment & Qualifications 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 homepage** section of the City & Guilds website also contains useful information such on such things as:

- **Walled Garden:** how to register and certificate candidates on line
- **Events:** dates and information on the latest Centre events
- **Online assessment:** information on how to register for e-assessments.

City & Guilds
Believe you can



www.cityandguilds.com

Useful contacts

UK learners

General qualification information

T: +44 (0)844 543 0033

E: learnersupport@cityandguilds.com

International learners

General qualification information

T: +44 (0)844 543 0033

F: +44 (0)20 7294 2413

E: **intcg@cityandguilds.com**

Centres

Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

E: **centresupport@cityandguilds.com**

Single subject qualifications

Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

F: +44 (0)20 7294 2404 (BB forms)

E: **singlesubjects@cityandguilds.com**

International awards

Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

E: **intops@cityandguilds.com**

Walled Garden

Re-issue of password or username, Technical problems, Entries, Results, e-assessments, Navigation, User/menu option, Problems

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

E: **walledgarden@cityandguilds.com**

Employer

Employer solutions, Mapping, Acation, Development Skills, Consultancy

T: +44 (0)121 503 8993

E: **business@cityandguilds.com**

Publications

Logbooks, Centre documents, Forms, Free literature

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

If you have a complaint, or any suggestions for improvement about any of the services that we provide, email: feedbackandcomplaints@cityandguilds.com

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