

City & Guilds Levels 2 and 3 Certificate in Refrigeration and Air Conditioning (6127)

Scheme handbook



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1. General information

This Award has been designed by City & Guilds in conjunction with the Industry Sector Skills Council (SummitSkills) as well as Refrigeration and Air Conditioning organisations to support government initiatives towards the National Qualifications Framework. It will contribute towards the knowledge and understanding required for the related NVQ while not requiring or proving evidence of occupational competence.

This award is aimed at candidates who

- are following Foundation & Advanced Modern Apprenticeship programmes
- require evidence towards the underpinning knowledge of the NVQ
- do not have immediate access to an NVQ
- wish for career progression within the Refrigeration and Air Conditioning industry
- wish to develop the knowledge learnt from Refrigeration and Air Conditioning Level 2 to progress to level 3.

This award is designed to cover & contribute towards the knowledge and understanding for the NVQs in Refrigeration and Air Conditioning Levels 2 & 3 (City & Guilds 6087). Scheme 6127 is a mandatory requirement in terms of underpinning knowledge evidence for those candidates achieving the NVQ scheme 6087

1.1 General structure

The award is made up of units expressed in a standard format. Each unit is preceded by details of the

- structure of the unit
- aims and general coverage of the unit
- relationship of the unit to the appropriate NVQ/ National Occupational Standards
- outcomes
- assessment methods.

1.2 Assessment and quality assurance

National standards and rigorous quality assurance are maintained by the use of

- City & Guilds set and marked multiple choice tests

Quality assurance includes initial centre approval, scheme approval, the centre's own procedures for monitoring quality and City & Guilds' ongoing monitoring by an External Verifier. Details of City & Guilds' criteria and procedures, including roles of centre staff and External Verifiers can be found in *'Providing City & Guilds Qualifications – a guide to centre and scheme approval'*.

Assessment components are graded (Pass). A pass is the achievement level required for the knowledge and understanding in an NVQ.

For candidates with particular requirements, centres should refer to City & Guilds policy document *'Access to assessment, candidates with particular requirements.'*

External verifiers act on behalf of City & Guilds to ensure that national standards are maintained. Full details of their role can be found in *'Providing City & Guilds' Qualifications - a guide to centre and scheme approval'*.

1.3 Course Design

Teacher/assessors should familiarise themselves with the structure and content of the award before designing an appropriate course; in particular they are advised to consider the knowledge and understanding requirements of the relevant NVQ.

City & Guilds does not itself provide courses of instruction, training, programmes of learning or specify entry requirements.

As long as the requirements for the award are met, teachers/assessors may design courses of study in any way that they feel best meets the needs and capabilities of the candidates. [Centres should combine and plan 6127 programmes with candidates site work (practical performance) requirements as linked to the NVQ scheme 6087]. Scheme 6127 programmes should therefore show a direct and relevant link to programmes leading to scheme 6087 NVQs in Refrigeration and Air Conditioning.

It is recommended that centres cover the following in the delivery of the course, where appropriate

- Key Skills (such as Communication, Application of Number, Information technology, Working with others, Improving own learning and performance, Problem solving)
- Health and safety considerations, in particular the need to impress to candidates that they must preserve the health and safety of others as well as themselves
- Environmental education
- European dimensions.

It is recommended that the following guided learning hours-GLH should be allocated:

Refrigeration and Air Conditioning	Level 2	400
Refrigeration and Air Conditioning	Level 3	400

1.4 Health and safety

The requirement to follow safe working practices is an integral part of all City & Guilds qualifications and assessments, and it is the responsibility of centres to ensure that all relevant health and safety requirements are in place before candidates start practical assessments.

Should a candidate fail to follow health and safety practice and procedures during an assessment (eg practical assignment) the test must be stopped and the candidate advised of the reasons why. The candidate should be informed that they have failed the assessment. Candidates may retake the assessment at a later date, no less than seven days after the failure.

1.5 City & Guilds Centre and Scheme approval

Centres wishing to offer City & Guilds qualifications must gain approval.

New centres must apply for centre and scheme approval.

Existing City & Guilds centres will need to get specific scheme 6127 approval to run this Award. Reference should also be made to scheme 6087 handbook for Assessor criteria and requirements.

Full details of the process for both centre and scheme approval are given in '*Providing City & Guilds qualifications - a guide to centre and scheme approval*' which is available from City & Guilds' regional offices.

1.6 Registration and Certification

- Candidates must be registered at the beginning of their course. Centres should submit registrations using Form S (Registration), under scheme number 6127 see qualification structure on page 17 for full details.

City & Guilds reserves the right to suspend an approved centre, or withdraw its approval from an approved centre to conduct a particular City & Guilds scheme or particular City & Guilds schemes. This might be for reasons of debt, malpractice or for any reason that maybe detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds.

- Full details on all the above procedures, together with dates and times of written tests will be found in the *Directory of Vocational Awards* published annually by City & Guilds. This information also appears on City & Guilds Web site <http://www.city-and-guilds.co.uk>

1.7 Verification of assessments

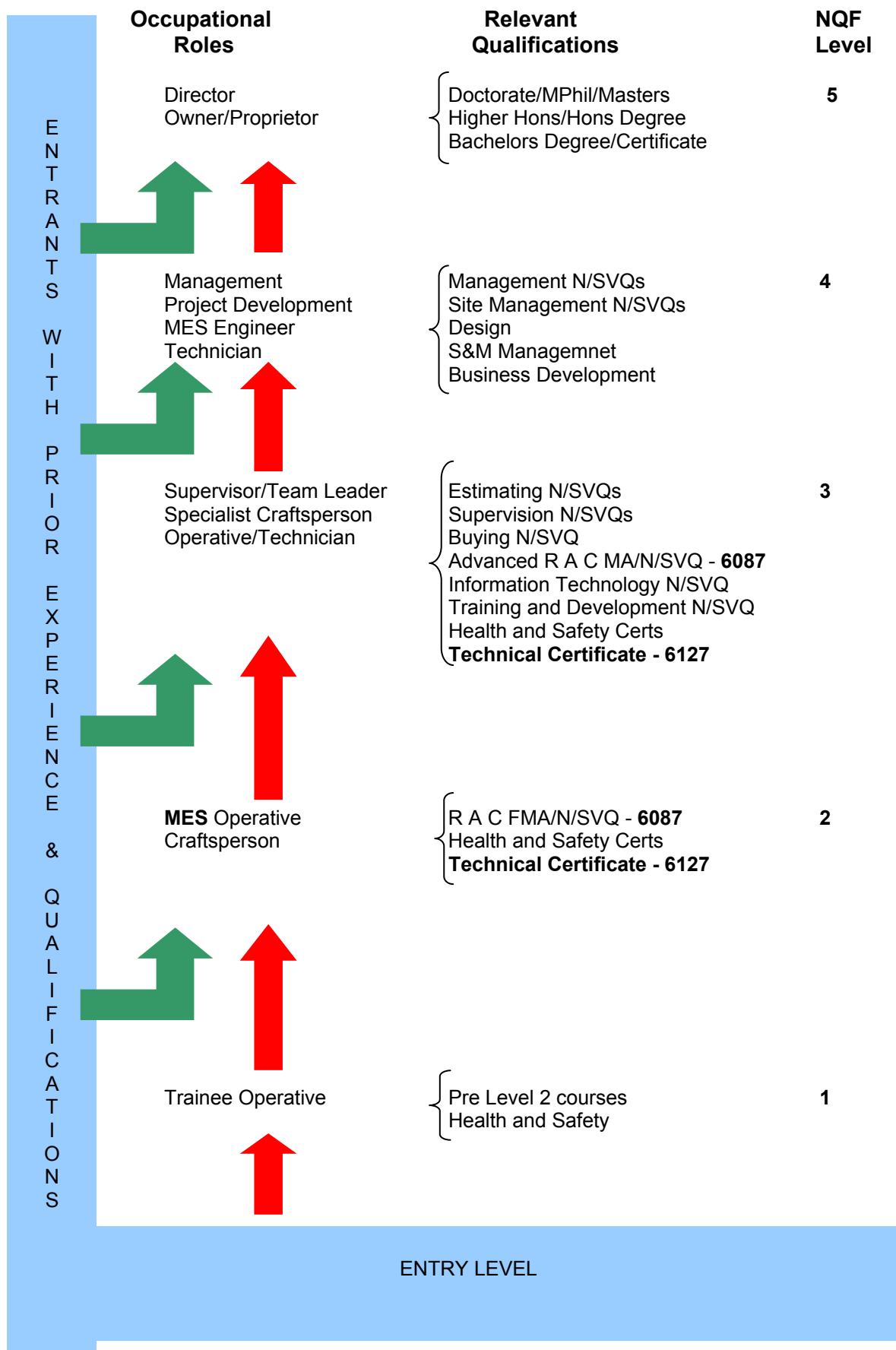
Although this Award does not imply occupational competence, it has a very close relationship with NVQ programmes. It is for this reason that, when the **6127 Technical Knowledge Tests** are used, it is important that reference is made to NVQ assessment methodology. Assessors/tutors will need to be familiar with the occupational standards for Refrigeration and Air Conditioning NVQs Scheme 6087.

1.8 External verification

An External Verifier will make an annual visit to the centre and their role includes the following:

- ensuring that internal verifiers are undertaking their duties satisfactorily
- monitoring internal quality assurance systems and sampling assessment activities, methods and records
- acting as a source of advice and support
- promoting best practice
- providing prompt, accurate and constructive feedback to all relevant parties on the operation of centres' assessment systems.

1.9 Refrigeration and Air Conditioning Sector Progression Routes



2. Guidance notes on assessment

2.1 Introduction

The City & Guilds Level 2 & 3 Refrigeration and Air Conditioning Award is designed to provide opportunities for candidates to gain accreditation for their individual level of understanding of the underpinning knowledge relevant to the appropriate related NVQ.

It became requirement within the Refrigeration and Air Conditioning Sector NVQ assessment strategy (endorsed by the Refrigeration and Air Conditioning Industry Sector/Summitskills-2003) that in order to satisfy the independent assessment requirements, all candidates who are registered and undergoing NVQ RAC programmes must complete and achieve scheme 6127 Certificate in Refrigeration at Level 2 or 3 before they are submitted for certificate/s for NVQ scheme 6087 at level 2 or 3.

Scheme 6127 covers the aspects of refrigeration and air conditioning knowledge associated with the underlying science and technological principles and are the essential underpinning knowledge that candidates require to complete a RAC NVQ. The applied performance requirement of the RAC NVQ also requires assessors to apply underpinning knowledge assessments to candidates in those areas that involve the candidate in the application of performance knowledge on the job. This must be recorded and added to candidate portfolios for external verifiers to access and verify as required. For the certificate: eg Level 2 or 3 Certificate in Refrigeration and Air Conditioning candidates will be required to achieve those components listed in the Qualification Structure on page 17.

2.2 Assessment

In order to gain the full certificate candidates MUST complete

ONE multiple-choice online (OL) paper for the core unit

This is a externally set and marked paper, available VIA City & Guilds Global Online Assessment (GOLA) system

and

TWO multiple-choice online (OL) papers for the technical units at each level

2.2.1 Assessment of Core unit

The core unit will be assessed by externally set and marked multiple choice GOLA (OL) question paper. This test will be available via City & Guilds from autumn/winter 2004. Each test will comprise of multiple choice items in accordance with the test specifications provided.

2.2.2 Assessment of technical units

The optional units will be assessed by externally set and marked, multiple choice GOLA (OL) question papers. These tests will be available via City & Guilds from autumn/winter 2004. Each test will comprise of multiple choice items in accordance with the test specifications provided.

2.3 What is provided by City & Guilds

City & Guilds will provide access to the City & Guilds Global On Line Assessment - GOLA for testing, using multiple choice questions online (OL).

2.4 Guidance for marking

All tests for scheme 6127 are externally set and marked.

3. The Award

3.1 Award Details

For the award of a certificate, candidates must successfully complete the assessments for Unit 101 and two technical component assessments applicable to the level the candidate is registered for

Core unit		Assessment components required	
101	Mechanical Engineering Services Core Studies	All 6127 complexes	Questions - multiple choice Externally set and marked
Units - Level 2 and 3			
201	Small Commercial Refrigeration and Air Conditioning Systems	6127-01 (Paper 1)	Questions - multiple choice Externally set and marked
	Outcomes -1, 2, 3 & 6		
202	Small Commercial Refrigeration and Air Conditioning Systems	6127-01 (Paper 2)	Questions - multiple choice Externally set and marked
	Outcomes -4 & 5		
301	Complex Refrigeration and Air Conditioning Systems	6127-02 (Paper 1)	Questions - multiple choice Externally set and marked
	Outcomes -1 & 2		
302	Complex Refrigeration and Air Conditioning Systems	6127-02 (Paper 2)	Questions - multiple choice Externally set and marked
	Outcomes -3 & 4		

Note that each unit (as printed in this document) has two component numbers to reflect that two question papers are set for assessments against each unit.

3.2 Test Specifications

Core Unit for Level 2 and 3

The knowledge requirements will be assessed by a multiple choice test

Subject **Refrigeration and Air Conditioning Level 2 & 3**

Paper No. 6127 - 101

Paper title Mechanical Engineering Services Core Studies

No of items - 30

Outcome	Topic / objective	No of items	%
01	Describe the MES sector the main bodies and organisations within the sector and the basic safety and communication issues that apply	5	16
02	Identify the physical forces that have an impact on themes sector	9	28
03	Interpret drawings, specifications, data and describe the use of IT in the sector	2	9
04	Describe the tools and the work processes used in the MES sector	8	25
05	Calculate and quantify from drawings and mark and set out	2	9
06	Understand building construction methods and the materials used in the MES sector	4	13
Totals		30	100

This note apply to all test specifications

Note:

The figures given for questions allocated against each outcome within each unit TEST SPECIFICATION may change, the figures given are therefore for guidance only.

Optional Units-Level 2**Subject Refrigeration and Air Conditioning Level 2****Paper No.** 6127-01 Paper 1 - 201**Paper title** Small Commercial Refrigeration and Air Conditioning Systems**No of items** 30

Outcome	Topic / objective	No of items	%
01	Refrigeration and Air Conditioning Industry structure, organisation and contribution to GDP	3	7
02	Energy Usage and the environment	3	7
03	Cooling Systems and Technology	21	79
06	Brazing Principles and Processes	3	7
Totals		30	100

Subject Refrigeration and Air Conditioning Level 2**Paper No.** 6127-01 Paper 2 - 202**Paper title** Small Commercial Refrigeration and Air Conditioning Systems**No of items** 30

Outcome	Topic / objective	No of items	%
04	Cooling Science and Calculations	20	65
05	Cooling System Electrics, electronics and controls	10	35
Totals		30	100

Optional Units-Level 2**Subject Refrigeration and Air Conditioning Level 3****Paper No.** 6127-02 Paper 1 - 301**Paper title** Complex Refrigeration and Air Conditioning Systems**No of items** 30

Outcome	Topic / objective	No of items	%
01	Energy and the environment	4	13
02	Cooling Systems and technology	26	87
Totals		30	100

Subject Refrigeration and Air Conditioning Level 3**Paper No.** 6127-02 Paper 2 - 302**Paper title** Complex Refrigeration and Air Conditioning Systems**No of items** 30

Outcome	Topic / objective	No of items	%
03	Cooling Science and Calculations	20	67
04	Cooling System Electrics, Electronics and Controls	10	33
Totals		30	100

3.3 Relationship to ESTLL/SUMMITSKILLS standards

Unit Number/Title	Related R A C Unit(s) NVQS Scheme 6087
Core unit – Level 2 and 3	
MES core Studies	001, 002, 003
Optional units - Level 2	
Small Commercial Refrigeration and Air Conditioning Systems	001, 002, 003, 005, 006
Optional units - Level 3	
Complex Refrigeration and Air Conditioning Systems	010, 011, 012, 013, 014, 015

3.4 Key/Core Skills Signposting

Achievement of a Key and Core Skill qualification is based upon the provision of evidence by a candidate which shows that he or she has carried out certain required activities. The following table indicates where there are opportunities for candidates to provide evidence which will enable them to achieve Key or Core Skills in such units. The identification of such opportunities is called 'signposting'. As a result, if the student has met the indicated vocational requirement of the unit, the relevant aspect of a Key or Core Skill may also be achieved.

Some of the Key or Core skills units may be achieved as a complete unit due to the diversity of skills required by the vocational unit.

Key skills mapping has been completed for the relevant NVQ units as identified in the table highlighting the relationship between the NVQ (6087) and the Technical Certificate (6127) and the link with the Certificate Units (see Page 15). Please refer to this to apply the key skills to this qualification.

Key for Key Skill Units

N/SVQ Unit – Guide to Units

C- Communication

WO – Working with others

PS – Problem solving

LP – Improving own learning and performance

AN - Application of Number

IT – Information Technology

Guide to Level Framework:

There are units at 5 levels, level 5 being the highest. For instance, levels 1 and 2 deal with straightforward subjects, levels 3 and above deal with more complex issues.

Level 2		Key Skills				
Units	C	N	IT	PS	LP	WO
Maintain the Safe Working Environment for HVACR Work Activities	1.1 1.2 1.3			1.1 1.2 1.3	1.1 1.2 1.3	1.1 1.2 1.3
Maintain Effective Working Relationships	2.1a 2.1b 2.2		1.1		1.1 1.2 1.3	2.1 2.2 2.3
Contribute to the Improvement of Business Products and Services for HVACR Work Activities	2.1a 2.1b 2.2 2.3	1.1 1.2 1.3		1.1 1.2 1.3	1.1 1.2 1.3	2.1 2.2 2.3
Plan RAC Work Activities	2.1a 2.1b 2.2 1.3	2.1 2.2		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Commission and Decommission RAC Systems	2.1a 2.1b 2.2 1.3	2.1 2.2		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Install RAC Systems and Components	2.1a 2.1b 2.2 1.3	1.1 1.2 1.3		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Service and Maintain RAC Systems and Components	2.1a 2.1b 2.2 1.3	1.1 1.2 1.3		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Design RAC Systems	2.1a 2.1b 2.2 2.3	2.1 2.2	1.2	2.1 2.2 2.3	1.1 1.2 1.3	
Specify Programmes for Working on RAC Systems	2.1a	2.1 2.2 2.3		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Level 3		Key Skills				
Units	C	N	IT	PS	LP	WO
Maintain the Safe Working Environment for HVACR Work Activities <ul style="list-style-type: none"> C/I a/c system C/I refrig Sys non ammonia Ammonia refrig system 	1.1 1.2 1.3			1.1 1.2 1.3	1.1 1.2 1.3	1.1 1.2 1.3
Maintain Effective Working Relationships <ul style="list-style-type: none"> C/I a/c system C/I refrig Sys non ammonia Ammonia refrig system 	2.1a 2.1b		1.1		1.1 1.2	3.1 3.2
Contribute to the Improvement of Business Products and Services for HVACR Work Activities <ul style="list-style-type: none"> C/I a/c system C/I refrig Sys non ammonia Ammonia refrig system 	2.1a 2.1b 2.2 2.3	1.1 1.2 1.3		2.1 2.2 2.3	1.1 1.2 1.3	

Plan Complex RAC Work Activities <ul style="list-style-type: none"> C/I a/c system C/I refig Sys non ammonia Ammonia refig system 	2.1a 2.1b 2.2 1.3	2.1 2.2		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Commission and Decommission Complex RAC Systems <ul style="list-style-type: none"> C/I a/c system C/I refig Sys non ammonia Ammonia refig system 	2.1a 2.1b 2.2 1.3	2.1 2.2		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Install Complex RAC Systems and Components <ul style="list-style-type: none"> C/I a/c system C/I refig Sys non ammonia Ammonia refig system 	2.1a 2.1b 2.2 1.3	1.1 1.2 1.3		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Service and Maintain Complex RAC Systems and Components <ul style="list-style-type: none"> C/I a/c system C/I refig Sys non ammonia Ammonia refig system 	2.1a 2.1b 2.2 1.3	1.1 1.2 1.3		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3
Design Complex RAC Systems <ul style="list-style-type: none"> C/I a/c system C/I refig Sys non ammonia Ammonia refig system 	2.1a 2.1b 2.2 2.3	2.1 2.2	1.2	2.1 2.2 2.3	1.1 1.2 1.3	
Specify Programmes for Working on Complex RAC Systems <ul style="list-style-type: none"> C/I a/c system C/I refig Sys non ammonia Ammonia refig system 	2.1a	2.1 2.2 2.3		2.1 2.2 2.3	1.1 1.2 1.3	3.1 3.2 3.3

4. Qualification structure and the Units

6127 Certificate in Refrigeration & Air Conditioning Systems – levels 2 and 3			6127
[This vocational award reflects the knowledge and understanding required for City & Guilds NVQ in Refrigeration and Air Conditioning scheme 6087]			
101	Mechanical Engineering Services Sector-Core Studies(OL)		
201	Small Commercial Refrigeration & Air Conditioning Systems-written-(OL)-Paper 1		
202	Small Commercial Refrigeration & Air Conditioning Systems-written-(OL)-Paper 2		
301	Complex Refrigeration & Air Conditioning Systems-written-(OL)-Paper 1		
302	Complex Refrigeration & Air Conditioning Systems-written-(OL)-Paper 2		
Complex 01		Level 2 Certificate in Small Commercial RAC systems	
Certificate		101 plus 201 and 202	
Complex 02		Level 3 Certificate in Complex RAC Systems	
Certificate		101 plus 301 and 302	
Registration - for the award/complex		Registration lasts for 5 years from the date made or until the certification end date, whichever is earlier. Use Walled Garden or Form S. Tick named registration. Enter appropriate complex number, eg 01 or 02.	
Registration for on-line tests (OL)		Candidates must be registered for all on-line tests. Use Walled Garden or Form S. Tick named registration. Enter appropriate complex number (eg -01 or -02) and the component number for the on-line test (<u>eg 201 etc</u>) There is no charge for this 'on-line tests' registration	
Scheduling on-line tests		Scheduling on-line tests (including re-sits) is done directly on the GOLA system (not Form S). On-line tests can be scheduled after 48 hours for registrations made via the Walled Garden or within 7 working days of receipt for Form S registrations	
Results submission for on-line tests		Results for all on-line tests are transferred automatically to City & Guilds.	
Invoice arrangements for on-line tests		On-line tests will be invoiced separately	
Fees per candidate		Registration -01 , -02 each Component entry per (OL) component Each full certificate awarded	£ 10.00 £ 15.00 £ 26.50
Registration for -01, or -02 awards		Registration lasts for 5 years from the date made or until the certification end date, whichever is earlier. Use Form S, tick Registration to enter candidates	
Results submission		Use Form S, tick Results submission for all components. Enter each component number claimed followed by P	
Documentation 6127 Award		For Awards handbook please see City & Guilds website-centres-award documentation-Refrigeration and Air Conditioning to down load or view	
Additional information			
<i>Award number</i>	<i>QCA reference</i>	<i>Last registration</i>	<i>Last certification</i>
6127-01	100/3510/2	30 September 2008	30 September 2010
6127-02	100/3511/4	30 September 2008	30 September 2011

City & Guilds Level 2 & 3 Certificate in Refrigeration and Air Conditioning

UNITS

- Mechanical Engineering Services Sector-Core Studies
- Small Commercial Refrigeration & Air Conditioning Systems
- Complex Refrigeration & Air Conditioning Systems

Unit 101 MES-Refrigeration and Air Conditioning-RAC Sector-Core Studies

Rationale

This core unit is concerned with the knowledge required to operate effectively within the RAC Sector. It describes the structure of the sector and the organisations involved in the sector. It also covers basic safety and communications so that people are aware of the issues that allow them to work safely and communicate effectively within the RAC sector.

The unit covers 6 performance outcomes. The candidate will be able to:

1. Describe the MES sector, the main bodies and organisations within the sector and the basic safety and communication issues that apply
2. Identify the physical forces that have an impact on the MES sector
3. Interpret drawings, specifications, data and describe the use of IT in the sector
4. Describe the tools and the work processes used in the MES sector
5. Calculate and quantify from drawings and mark and set out
6. Understand building construction methods and the materials used in the MES sector

Connection with other awards

This unit is derived from ESTTL's Training Specifications, in particular Foundation Training Module 2. This unit is common across Heating and Ventilating and Refrigeration and Air Conditioning NVQs and is a precursor to the following NVQs for the sector:

1. Scheme 6087 Refrigeration and Air Conditioning Systems (levels 2 & 3)

Assessment

The unit outcomes will be assessed via a multiple choice paper. The structured assessment paper will cover the 6 outcomes specified. The paper will be externally set and externally marked.

Outcome101. 1: Describe the RAC sector, the main bodies and organisations within the sector and the basic safety and communication issues that apply

Underpinning Knowledge

The candidate will be able to

1. Describe the structure of the RAC industry
2. Describe the career paths and progression routes within the RAC sector and the education and training opportunities available
3. List the main acts and regulations governing health and safety in the workplace
4. Describe the protective clothing applicable to various work processes and the accident prevention methods that ensure a safe working environment
5. List the different types of access equipment used within the RAC sector and describe the safe usage, the limitations that apply and the potential hazards
6. List the potential hazards associated with hand and power tools and the safe measures to adopt when using them
7. Describe the causes of fire and the methods to adopt when tackling different categories of fire using the correct equipment
8. State the correct procedures for locating and isolating services before starting to cut and drill and list the services
9. Describe the structural considerations that apply when cutting into floors, walls and ceilings and state the potential consequences of ignoring these considerations
10. List the general rules that apply to safe work practices and define the consequences of an untidy work location/poor housekeeping and state the potential risk of injury or damage to health arising from these situations
11. Describe the value of good communications and personal presentation as they apply to the workforce, employers and the industry
12. Describe the value of sketches as an aid to information and communications
13. Complete time sheets, expenses forms accurately ensuring that all the necessary information is included and that the calculations are correct
14. List the important aspects of oral communication both face to face and via communication devices

Outcome101. 2: Identify the physical forces that have an impact on the RAC sector

Underpinning Knowledge

The candidate will be able to

1. State the main points relating to the basic physical quantities as they relate to the RAC sector, describe the main principles and apply relevant calculations
2. State the principles and theories relevant to pressure and explain
 - a. Pressure
 - b. Saturation Pressure
3. Describe the main principles associated with heat, and relate the following to applications in the RAC sector
 - a. Heat as energy
 - b. Change of state – melting and solidifying
 - c. Change of state – evaporation and condensation
 - d. Heat transfer
5. Describe the main principles associated with thermal movement, and relate the following to applications in the RAC sector
 - a. Temperature
 - b. Thermal movement of solids
6. Describe the principles of
 - a. Work
 - b. Power
10. State the basic principles of electricity and describe how they can be applied to RAC system circuits electrical circuits and motors
11. Describe the potential hazards of working with or near electrical supply systems and the safe practices and precautions to apply
12. Identify the main items of electrical supply systems to buildings and to temporary supplies on construction sites and describe the function of the identified items
13. State the advantages of using reduced voltage supplies on site and the correct method of using step down transformers
14. State the colour code for electrical cables and flexible cords and use it to identify the live, earth and neutral and describe how to wire up a 2 and 3 core cable so that the correct wires are connected to the correct terminal
15. Describe how to
 - a. Assess fuse ratings for various RAC applications
 - b. Locate, repair and replace a circuit fuse which has failed
 - c. Locate, check and replace a defective cartridge fuse that has failed
 - d. Locate and reset miniature circuit breakers and residual current devices using safe methods
16. Describe the checks to be made on electrical equipment prior to use
17. State the correct procedure for isolating someone from the live source and the procedure for dealing with a person suffering the effects of electrical shock

Outcome 101. 3: Interpret drawings, specifications, data and describe the use of IT in the sector

Underpinning Knowledge

The candidate will be able to

1. Describe the use of drawings as an aid to installation and service and maintenance activities
2. Describe how specifications are used within the RAC sector
3. Describe how Technical Standards are used to communicate information in a common format
4. Construct a basic operation sheet or a plan from a simple drawing in a logical and structured sequence
5. Identify from drawings, specification and data sheets the various components featured
6. Identify and interpret manufacturers instructions in order to extract specific information
7. Identify the use of colour coding within the RAC sector and use to identify
 - a. Electrical components and wiring
 - b. Content of pipes and vessels
 - c. Cylinders for gases or refrigerants

Outcome 101. 4: Describe the tools and the work processes used in the RAC sector

Underpinning Knowledge

The candidate will be able to

1. Identify the tools commonly used within the RAC sector and be able to distinguish between hand and power tools
2. Describe the correct and safe use of the tools found in the RAC sector
3. State the maintenance requirements of these tools and explain why tool maintenance is required
4. State the correct storage environment for tools and why this is necessary
5. List the specialist tools required for the refrigeration and air conditioning disciplines for Refrigeration and Air Conditioning.
9. List and identify the tools and equipment used for fixing to different types of surface and materials and know the relationship between
 - a. Drill, screw and fixing sizes
 - b. Fixing strength and supporting weight
10. List the different methods and principles of jointing used in the RAC sector and describe the jointing by
 - a. Mechanical methods
 - b. Application of heat methods
 - c. Solvent methods
11. List the tools, equipment and materials for different jointing operations for particular conditions

Outcome 101. 5: Calculate and quantify from drawings

Underpinning Knowledge

The candidate will be able to

1. Read and interpret simple plans and drawing to quantify material requirements
2. Explain the purpose of drawings
3. Use measuring and calculating methods correctly to determine
 - a. Areas
 - b. Volumes
 - c. Quantities

Underpinning Knowledge

The candidate will be able to

1. State the main functions of the components which make up a simple building
2. List the internal construction parts of a simple building and the factors and functions that are applicable
3. List the principal services required of a simple building and the implication for the construction
4. List the safe and correct methods for removing and replacing constructional elements
5. List and describe the correct procedures for undertaking basic building tasks in relation to RAC activities
6. Identify typical RAC fittings and pipework materials and list the general characteristics of
 - a. Copper tube
 - b. Plastic pipe
 - c. Brass fittings
 - d. Copper fittings
7. Describe the use by the RAC sector of the following materials
 - a. Copper
 - b. Aluminium
 - c. Brass
 - d. Plastics
8. List the main building materials which may be encountered when working in the RAC sector and describe the general characteristic of each identified material
9. Describe the safety requirements that apply when dealing with thermal insulation materials
10. List the materials used for insulation and cladding and describe how these materials are used
11. List the typical applications for insulation
12. State the dangers associated with asbestos and describe the actions required when asbestos is encountered

Unit 201/202 Small Commercial Refrigeration & Air Conditioning Systems

Level 2

Rationale

This unit is concerned with the core underpinning knowledge required to install, commission, de-commission, service and maintain small refrigeration and air conditioning systems. The unit deals with the refrigeration and air conditioning industry structure, organisation and scope. It includes the use of energy and the impact of cooling systems, principles of brazing copper pipe work systems and the principles of electrics, electronics and control.

This unit is relevant to candidates who are working towards a qualification in Small Refrigeration and Air Conditioning Systems.

This unit covers six learning outcomes, the candidate will be able to:

1. Describe the structure and organisation of the RAC industry and its contribution to GDP.
2. Explain the relationship between cooling systems, energy usage and the environment.
3. Describe and explain cooling systems and technology
4. Explain the basic science of cooling and use charts to calculate quantities
5. Describe and explain small cooling system electrics, electronics and control
6. Describe and explain brazing principles and processes

This unit combines and extends the knowledge and understanding required for NVQ units:

1. Maintain the safe working environment for HVACR activities
2. Maintain effective working relationships
3. Contribute to the improvement of business products and services for HVACR activities
4. Plan RAC work activities
5. Commission and de-commission RAC systems
6. Install RAC systems and components
7. Service and maintain RAC systems and components

of the RAC Occupational Standards

Assessment

The outcome of this unit will be assessed using two multiple choice assessment papers/tests. There will be two tests, synoptically written which will cover the content of the six outcomes. These written tests will be externally set and externally marked.

Unit 201 Small Refrigeration & Air Conditioning Systems	
1. RAC industry structure, organisation and contribution to GDP.	<ul style="list-style-type: none"> a) Describe the scope of the RAC industry b) Describe the role of the various trade associations, professional institutions and industry board c) Describe the importance of cooling to UK industry
2. Energy and the environment	<ul style="list-style-type: none"> a) Describe the impact of cooling systems on the global environment b) Describe the importance of the efficient use of energy by cooling systems c) Explain the difference between Direct and Indirect Global Warming Impact d) Explain why modern refrigerants (HCs & HFCs) are used in preference to CFCs and HCFCs
3. Cooling systems and technology	<ul style="list-style-type: none"> a) Describe construction, function and operating principles of: <ul style="list-style-type: none"> i. Compressors – reciprocating, rotary, scroll ii. Condensers – air cooled iii. Evaporators – dx or flooded iv. Expansion device – capillary, TEV (internally and externally equalised) v. Liquid line driers vi. Suction line driers vii. Accumulators – suction line viii. Liquid receivers ix. Four way reversing valves b) Explain the operating principles of small commercial refrigeration systems for both chill and frozen applications including defrosting procedures c) Explain the operating principles of small air conditioning split systems for both ‘cooling only’ and ‘heat pumping’ applications
4. Brazing principles and processes	<ul style="list-style-type: none"> a) describe the process of brazing copper to copper b) describe the principles of brazing copper to steel c) explain how to maintain oxy-acetylene brazing equipment d) explain how to store brazing equipment while using it on site e) describe the safety precautions required before, during and after brazing operation
5. Cooling science and calculations	<ul style="list-style-type: none"> a) describe heat transfer processes by each of: <ul style="list-style-type: none"> i. conduction ii. convection iii. radiation b) describe pressure-temperature relationship c) explain the different conditions : <ul style="list-style-type: none"> i. liquid ii. vapour iii. sub cooled liquid iv. saturated liquid v. saturated two phase mixture vi. saturated vapour vii. superheated vapour d) plot basic cycles of vapour compression refrigeration system on pressure enthalpy diagram e) calculate refrigeration effect, condenser heat rejected, compressor work done, using plotted values on pressure enthalpy diagram f) plot basic processes of sensible cooling, sensible heating, humidification and de-humidification on a psychrometric chart g) solve basic cycle calculations for cooling capacity motor power input, rate of condenser heat rejection

<ul style="list-style-type: none"> h) describe refrigerant properties of toxicity, flammability, combustibility i) describe refrigerant properties of density, specific volume, latent heat, thermal conductivity, miscibility j) describe the properties of zeotropic blends, azeotropes and single fluid refrigerants k) describe the desirable properties of lubricants l) describe the properties of insulating materials
<p>6. Cooling system electrics, electronics and controls</p> <ul style="list-style-type: none"> a) describe electrical principles of conduction, resistance, current and voltage b) solve problems using Ohms Law c) explain series and parallel circuits d) describe basic AC circuit theory e) describe basic DC circuit theory f) describe the principles of single phase induction motors g) explain the motor starting control circuits found in small refrigeration and air conditioning systems (in the range of Level 2 NVQ) h) describe operating control circuits which include thermostat, low pressure switch, high pressure switch, over current/over temperature protection. Solenoid valve for pump-down and for reverse direction (heat pump mode) i) explain the use of basic electrical testing meters- multi meters, megger meter

Unit 301/302 Complex Refrigeration and Air Conditioning Systems

Level 3

Rationale

This unit is concerned with the underpinning knowledge required to install, commission, de-commission, service and maintain complex commercial and industrial refrigeration and air conditioning systems. The unit deals with energy efficiency and environmental impact and it includes the technology of complex refrigeration and air conditioning systems. The unit also deals with cooling science and calculations and complex cooling systems electrotechnics and control.

This unit is relevant to candidates who are working towards a qualification in Commercial and Industrial Refrigeration and/or Air Conditioning Systems (Level3).

This unit covers four learning outcomes, the candidate will be able to:

1. Compare and contrast factors which affect energy efficiency and total environmental warming impact.
2. Describe complex cooling system technology
3. Use applied cooling science to carry out load, performance and equipment selection calculations.
4. Describe and explain cooling system electrotechnics and control

This unit combines and extends the knowledge and understanding required for units:

1. Maintain safe working environment for HVACR activities
2. Maintain effective working relationships
3. Contribute to the improvement of business products and services for HVACR activities
10. Plan complex RAC work activities
11. Commission and de-commission complex RAC systems
12. Install complex RAC systems and components
13. Service and maintain complex RAC systems and components

of the RAC Occupational Standards

Assessment

The outcome of this unit will be assessed multiple by two multiple choice assessment papers. There will be two tests synoptically written which will cover the content of the four outcomes. These written tests will be externally set and externally marked.

Unit 301/302 Commercial and Industrial Refrigeration and Air Conditioning Systems	
1. Energy and the Environment	<ul style="list-style-type: none"> a) Calculate TEWI (Total Environmental Warming Impact) b) Compare and contrast TEWI for a variety of different refrigerants applied to the same cooling capacity and operating temperatures. c) Describe the methods to improve energy efficiency on existing systems within the range.
2. Cooling Systems and Technology	<ul style="list-style-type: none"> a) Describe system layout and operating principles for multi compressor pack systems with capacity control. b) Describe system layout and operating principles for multi evaporator systems with independent control for each evaporator. c) Explain the principles of: <ul style="list-style-type: none"> - oil separation, recovery and rectification - hot 'gas', saturated 'gas' and electric defrost systems - pumped liquid recirculation systems - variable refrigerant volume/flow systems d) Describe the main operating features and characteristics of each of the following compressor systems <ul style="list-style-type: none"> - screw - scroll - centrifugal - rotary e) Describe the features and characteristics of expansion devices in current use f) Describe the operating principles and application of suction pressure, evaporating pressure and crankcase pressure regulating valves g) Describe the system layout and operating principles for water chilling systems h) Describe the system layout and operating principles for central air conditioning systems
3. Cooling Science and Calculations	<ul style="list-style-type: none"> a) Compare and contrast system performance at a variety of conditions using pressure enthalpy diagrams b) Compare and contrast air conditioning processes using the psychrometric chart c) Apply equipment and components to cooling applications to allow system selection, design and balancing to be carried out d) Describe the effect of heat and vapour transfer to insulated structures e) Compare and contrast the use of different refrigerant types in cooling applications f) Explain the features and characteristics of zeotropic blends, azeotropes and single fluid refrigerants g) Assess heat loads to insulated cooled applications h) Explain Dalton's Law of Partial Pressures i) Describe Boyles Law Charles' Law and the Combined Gas Equation.
4. Cooling System Electrics, Electronics and Controls	<ul style="list-style-type: none"> a) Describe electrical circuits for systems in the range b) Explain the principles of electronic monitoring systems (EMS) and building monitoring systems (BMS) c) Describe the principles of single phase and three phase motor and motor control and protection circuits d) Describe the requirements of the Electricity at Work Regulations and the Institute of Electrical Engineering Regulations e) Trace and explain electrical circuit diagrams for systems in the range

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