

# **Level 3 Diploma in Refrigeration, Air- Conditioning and Heat Pump Systems (6090-30)**

**Version 1.5 (September 2019)**

**Qualification Handbook**

## Qualification at a glance

<b>Subject area</b>	Refrigeration and Air-conditioning
<b>City &amp; Guilds number</b>	6090
<b>Age group approved</b>	16-19, 19+
<b>Assessment types</b>	Multiple Choice; Assignment
<b>Approvals</b>	Fast track approval
<b>Support materials</b>	Assessment pack; Qualification handbook
<b>Registration and certification</b>	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds qualification number	Ofqual accreditation number
Level 3 Diploma in Refrigeration, Air-Conditioning and Heat Pump Systems	372	557	6090-30	603/1190/3

Version and date	Change detail	Section
1.1 January 2017	TQT reduced as unit 307 has been removed	Unit
1.2 March 2017	QAN number added	Qualification at a Glance
1.3 June 2017	Automatic approval is given to anyone currently delivering the 6187 or 7189.	Centre Requirements - Approval
1.4 November 2017	References to 307 removed	Assessment
1.5 September 2019	Amended 501 test specification	Assessment

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# 1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	This qualification is for learners wishing to pursue a career within the Refrigeration & Air-conditioning industry.
What does the qualification cover?	<p>This qualification covers the knowledge and occupational skills required to work in installing and commissioning air-conditioning and heat pump system.</p> <p>The Refrigeration Air Conditioning and Heat Pump (RACHP) Engineering Technician is a specialist occupation involved in planning, preparing and safely carrying out work activities in process, product and space cooling.</p>
What opportunities for progression are there?	The Refrigeration Air Conditioning and Heat Pump (RACHP) Engineering Technician will enable candidates to progress within employment.
Who did we develop the qualification with?	<p>This product was developed by a number of employers within the Refrigeration &amp; Air-conditioning industry:</p> <ul style="list-style-type: none"><li>• Enigma Environmental Services Ltd</li><li>• GEA Refrigeration</li><li>• Integral UK Ltd</li><li>• Mitsubishi Electric Living Environmental Systems</li><li>• Star Refrigeration</li><li>• Space Engineering Services</li><li>• Carter Synergy</li><li>• Adcock Refrigeration and Air conditioning</li><li>• Epta Group</li><li>• Sainsbury's</li><li>• Daikin Airconditioning UK Ltd</li><li>• MacWhirter Air Conditioning</li></ul>
Is it part of an apprenticeship framework or initiative?	The qualification is the new Trailblazer initiative set up by the government to promote apprenticeships within the Refrigeration & Air-conditioning industry.

## Level 3 Diploma in Refrigeration, Air-Conditioning and Heat Pump Systems

City & Guilds unit number	Unit title	GLH
<b>Mandatory</b>		
201	Health and safety in RACHP industry	40
301	Applying fundamental principles to RACHP systems	116
302	Complex RACHP systems	69
303	Commissioning and troubleshooting complex RACHP systems	71
304	Work planning and organisation for RACHP systems	30
305	Electrical power and control for RACHP systems	156

### Total Qualification Time

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to achieve and demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT is comprised of the following two elements:

- 1) The number of hours which an awarding organisation has assigned to a qualification for Guided Learning, and
- 2) an estimate of the number of hours a Learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by - but, unlike Guided Learning, not under the Immediate Guidance or Supervision of - a lecturer, supervisor, tutor or other, appropriate provider of education or training.

Title and level	GLH	TQT
Level 3 Diploma in Refrigeration, Air-Conditioning and Heat Pump Systems	372	557

## 2 Centre requirements

### Approval

If your Centre is approved to offer the qualification 7189-03 Level 3 Diploma in Refrigeration, Air Conditioning and Heat Pump Systems or 6187-03/04/05 then you will receive automatic approval for the new 6090-30 Level 3 Diploma in Refrigeration, Air-conditioning and Heat Pump Systems.

To offer these qualifications, new centres will need to gain both centre and qualification approval. Please refer to the Centre Manual - Supporting Customer Excellence for further information.

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

### Resource requirements

#### *Resources*

Centres can use specially designated areas within a centre to develop practical skills and to assess the simulated practical assignments. The equipment, systems and machinery must meet industrial standards and be capable of being used under normal working conditions.

#### *Centre staffing*

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

- be occupationally competent or technically knowledgeable in the area[s] for which they are delivering training and/or have experience of providing training. This knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

See also the assessment strategy on the role of supervisors and managers in the assessment process.

Centre staff may undertake more than one role, eg tutor and assessor or internal verifier, but cannot internally verify their own assessments.

### Learner entry requirements

City & Guilds does not set entry requirements for these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualifications successfully.

### Age restrictions

City & Guilds cannot accept any registrations for learners under 16 as these qualifications are not approved for learners under 16.

### 3 Delivering the qualification

#### Initial assessment and induction

An initial assessment of each candidate should be made before the start of their programme to identify:

- if the candidate has any specific training needs
- support and guidance they may need when working towards their qualifications
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification[s], their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

#### Support materials

The following resources are available for these qualifications:

Description	How to access
Assessment pack	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

#### Recording documents

Candidates and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, Learning Assistant, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: [www.cityandguilds.com/eportfolios](http://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. Recording forms are available on the City & Guilds website.

Although new centres are expected to 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 Assessment

### Summary of assessment methods

#### ***Candidates must:***

- successfully complete assignments for a number of mandatory units
- successfully complete evolve tests for a number of mandatory units

#### ***Available assessments/assignments***

City & Guilds has written the following assessments to use with this qualification:

- assignments for units 301-306
- evolve tests, including different versions for the unit 201

City & Guilds has written guidance for centres to write their own assessments/assignments.

City & Guilds has developed a template which tutors/assessors can use to write their own assignments.



## Assessment Types

Unit	Title	Assessment method	Where to obtain assessment materials
201	Health and safety in RACHP industry	Assignment	6090 web page on City and Guilds website.
501	Health and safety in RACHP industry	Multiple Choice Test	Evolve, City and Guilds On-screen Assessment Platform
301	Applying fundamental principles to RACHP systems	Assignment	6090 web page on City and Guilds website.
302	Complex RACHP systems	Assignment	6090 web page on City and Guilds website.
303	Commissioning and troubleshooting complex RACHP systems	Assignment	6090 web page on City and Guilds website.
304	Work planning and organisation for RACHP systems	Assignment	6090 web page on City and Guilds website.
305	Electrical power and control for RACHP systems	Assignment	6090 web page on City and Guilds website.

### ***Time constraints***

Details of timings can be found within the assessment pack.

Evolve Test Durations are as follows;

Unit Number	Unit Title	Test Duration (Minutes)
501	Health and safety in RACHP industry	45

## Assessment strategy

Tables and content pertaining to the assessment strategy

### Test Specifications

The way the knowledge is covered by each test is laid out in the table(s) below:

6090-501	Health and safety in RACHP industry Duration 45 minutes	
Learning outcome	Outcome	No. of questions
01	Know health and safety legislation	4
02	Know how to handle hazardous situations	9
03	Know electrical safety requirements when working in the RACHP industry	6
04	Know the safety requirements for working with gases and heat producing equipment	6
05	Know the safety requirements for using access equipment in the RACHP industry	n/a
06	Know the safety requirements for working safely in excavations and confined spaces in the RACHP industry	3
<b>Total</b>		<b>28</b>

### Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience, or qualifications which have already been achieved, to contribute to a new qualification.

For this qualification, RPL is allowed and is not sector specific.

## 5 Units

### Availability of units

Some of the units can be found in a separate document.

### Structure of the units

These units each have the following:

- City & Guilds reference number
- Unit Accreditation Number (UAN)
- Title
- Level
- Notional learning hours (NLH)
- Guided learning hours (GLH)
- Learning outcomes, which are comprised of a number of assessment criteria

Centres must deliver the full breadth of the range. Specialist equipment or commodities may not be available to all centres, so centres should ensure that their delivery covers their use. This may be covered by a practical demonstration (e.g. video). For the practical assessments for this qualification, centres should ensure that there are sufficient resources to complete the task but are not required to use all the equipment or commodities in the range.

## Unit 201

## Health and safety in RACHP industry

<b>Unit level:</b>	Level 2
<b>GLH:</b>	40
<b>Unit aim:</b>	This combination unit provides learners with the essential health and safety knowledge and skills to demonstrate best practice in a RACHP engineering environment. The unit provides learners with an awareness of relevant legislation and should underpin all RACHP engineering activities learners take part in.

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### Learning outcome

The learner will:

- 1 Know health and safety legislation

### Assessment criteria

The learner can:

- 1.1 state the aims of health and safety legislation
- 1.2 identify the responsibilities of individuals under health and safety legislation
- 1.3 identify statutory and non-statutory health and safety documentation
- 1.4 identify the different roles of Health and Safety Executive in enforcing health and safety legislation.

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### Range

- (AC1.1) **Health and safety legislation:** The Health & Safety at Work Act, The Electricity at Work Regulations, Control of Substances Hazardous to Health (COSHH) Regulations, Working at Heights Regulations, Personal Protective Equipment at Work Regulations (PPE), Lifting and Manual Handling Operations Regulations, Provision and Use of Work Equipment Regulations (PUWER), Control of Asbestos at Work Regulations, Health, Safety and Welfare Regulations, Health and Safety (First Aid) Regulations, Confined Spaces Regulations, Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)
- (AC1.2) **Individuals:** Employers, employees and contractors, visitors to site
- (AC1.3) **Health and safety documentation:** Acts of Parliament, regulations, approved codes of practice, HSE Guidance notes.
- (AC1.4) **Roles:** Improvement notice, prohibition notice, powers of prosecution, providing advice and guidance

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## Learning outcome

The learner will:

- 2 Know how to handle hazardous situations

## Assessment criteria

The learner can:

- 2.1 identify common hazardous situations found on site
- 2.2 describe safe systems at work
- 2.3 identify the categories of safety signs
- 2.4 identify symbols for hazardous substances
- 2.5 list common hazardous substances used in the RACHP industry
- 2.6 list precautions to be taken when working with hazardous substances
- 2.7 identify the types of asbestos that may be encountered in the workplace
- 2.8 identify the actions to be taken if the presence of asbestos is suspected
- 2.9 describe the implications of being exposed to asbestos
- 2.10 state the application of different types of personal protective equipment
- 2.11 identify the procedures for manually handling heavy and bulky items
- 2.12 identify the actions that should be taken when an accident or emergency is discovered
- 2.13 state procedures for handling injuries sustained at work
- 2.14 state the procedures for recording accidents and near misses at work.

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## Range

- (AC2.1) **Hazardous situations:** Trailing leads, slippery or uneven surfaces, presence of dust and fumes, handling and transporting equipment or materials, contaminants and irritants, fire, working at heights, malfunctioning equipment, improper use and storage of tools and equipment, potential presence of asbestos
- (AC2.2) **Safe systems at work:** Method statements, permit to work systems, risk assessments, safety signs and notices
- (AC2.3) **Categories:** Mandatory, prohibition, information, warning
- (AC2.4) **Symbols:** Toxic, harmful, corrosive, irritant, oxidising, extremely flammable
- (AC2.5) **Hazardous substances:** Solvents and lubricants, fluxes, jointing compounds, sealants, gases – LPG, oxy-acetylene and carbon dioxide, cleaning agents
- (AC2.6) **Precautions:** PPE, ventilation, risk assessment, method statements, safe systems of work.
- (AC2.7) **Types of asbestos:** White asbestos (Chrysotile), brown or grey asbestos (Amosite), blue asbestos (Crocidolite), asbestos cement materials
- (AC2.8) **Actions:** Stop working immediately, report to supervisor.
- (AC2.9) **Implications:** Long-term health implications (mesothelioma, asbestosis)
- (AC2.10) **Personal protective equipment:** Protection for: clothing (high visibility), eyes, hands, head, feet, hearing, respiratory system

- (AC2.11 **Procedures for manual handling:** Single, two-person lift, mechanical lift
- (AC2.12 **Actions:** Raising the alarm, contact emergency services, follow typical emergency evacuation procedures, inform supervisor.
- (AC2.13 **Procedures for handling injuries:** Make self safe, make area safe, contact nominated first aid person and/or emergency services, report to the responsible person.
- (AC2.14 **Procedures for recording accidents:** RIDDOR, the use of company accident books, details to be recorded.
- 

### Learning outcome

The learner will:

- 3 Know electrical safety requirements when working in the RACHP industry

### Assessment criteria

The learner can:

- 3.1 identify the common electrical dangers to be aware of at work
- 3.2 list different sources of electrical supply for tools and equipment
- 3.3 describe reasons for using reduced voltage electrical supplies for tool and equipment at work
- 3.4 identify how to conduct a visual inspection of portable electrical equipment for safe condition before use
- 3.5 state actions to take when portable electrical equipment fails visual inspection
- 3.6 outline the Safe Isolation Procedure
- 3.7 state the procedures for dealing with electric shocks.
- 

### Range

- (AC3.1) **Electrical dangers:** Faulty electrical equipment, damaged electrical equipment, exposed conductors, damaged insulation, worn electrical cables and cords, trailing cables, proximity of cables, buried/hidden cables
- (AC3.2) **Sources:** Battery powered supplies, 110 volt supplies, 230 volt supplies, generating sets
- (AC3.3) **Reasons:** Increased likelihood for damage to equipment, operative in better contact with earth, protect from electric shock, reduces trailing leads.
- (AC3.4) **Visual inspection:** Checking for a valid PAT test, Inspection for general condition
- (AC3.5) **Actions:** Remove from use, report to supervisor
- (AC3.6) **Safe Isolation Procedure:** Working live is only permitted under special circumstances
- (AC3.7) **Procedures:** Removal from supply, CPR method, contact emergency services, report to supervisors, treatment of minor burns
- 

### Learning outcome

The learner will:

- 4 Know the safety requirements for working with gases and heat producing equipment
-

## Assessment criteria

The learner can:

- 4.1 identify different types of gases used at work
  - 4.2 describe how gas cylinders and equipment should be safely transported and stored
  - 4.3 describe how to conduct a visual inspection on heat producing equipment for safe condition
  - 4.4 describe how combustion takes place
  - 4.5 state the dangers of working with heat producing equipment
  - 4.6 state the procedures to follow on discovery of fires at work
  - 4.7 identify different classifications of fires
  - 4.8 identify types of fire extinguisher for different classifications of fires.
- 

## Range

(AC4.1) **Types of gases:** Propane, butane, oxy-acetylene, nitrogen

(AC4.3) **Visual inspection:** Inspection for general condition

(AC4.4) **Combustion:** Three elements of the fire triangle

(AC4.5) **Dangers:** Fires, burns, fumes, equipment damage, explosions

(AC4.6) **Procedures:** Raise the alarm, follow safety evacuation procedures, call emergency services

(AC4.7) **Classifications of fires:** Class A, B, C, D, electrical fires

(AC4.8) **Fire extinguisher:** Carbon dioxide, water, powder, foam

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## Learning outcome

The learner will:

- 5 Know the safety requirements for using access equipment

## Assessment criteria

The learner can:

- 5.1 identify different types of access equipment
  - 5.2 select suitable equipment for carrying out work at heights based on the work being carried out
  - 5.3 describe the safety checks to be carried out on access equipment
  - 5.4 describe safe erection methods for access equipment.
- 

## Range

(AC5.1) **Types of access equipment:** Step ladders, ladders, roof ladders and crawling boards, mobile tower scaffolds, podiums fixed scaffolds and edge protection, mobile elevated work platforms including scissor lifts and cherry pickers, telescopic ladders

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- (AC5.2) **Work being carried out:** Duration at work, action points for heights
- (AC5.3) **Safety checks:** Visual, tagging, fit for purpose, secure level ground, operative's competency for use of equipment
- (AC5.4) **Access equipment:** Step ladders, ladders, roof ladders, mobile tower scaffolds, podiums, telescopic ladders
- 

### Learning outcome

The learner will:

- 6 Know the safety requirements for working safely in excavations and confined spaces in the RACHP industry

### Assessment criteria

The learner can:

- 6.1 identify the situations in which it may be necessary to work in excavations
- 6.2 describe how excavations should be prepared for safe working
- 6.3 state precautions to be taken to make excavations safe
- 6.4 identify areas in which may become a confined space
- 6.5 state safety considerations when working in confined spaces.
- 

### Range

- (AC6.2) **Prepared:** Safe access into the excavation, trench support systems
- (AC6.3) **Precautions:** Use of warning signs, use of barriers, vehicle proximity to excavation edges
- (AC6.4) **Confined space:** Drainage systems, plant rooms, main service duct-rooms, in tanks, cylinders, boilers or cisterns, under suspended timber floors, in roof spaces.
- (AC6.5) **Safety considerations:** Ventilation, lighting, PPE, evacuation procedures, medical conditions, lone working
- 

### Learning outcome

The learner will:

- 7 Be able to apply safe working practice.

### Assessment criteria

The learner can:

- 7.1 perform manual handling techniques
- 7.2 demonstrate the safe method of assembly of access equipment
- 7.3 use access equipment safely.
-



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**Range**

(AC7.1) **Manual handling:** Single, two-person lift, using mechanical lifting aids

(AC7.2) **Access equipment:** Step ladders, ladders, mobile tower scaffolds

## Unit 301

## Applying fundamental principles to RACHP systems

<b>Unit level:</b>	Level 3
<b>GLH:</b>	116
<b>Unit aim:</b>	This unit allows learners to explore fundamental principles to develop their understanding of RACHP systems. There is particular emphasis on system design and efficiency and the use of both Ph and psychrometric charts as data sources. The unit concludes with theoretical calculations being applied to a range of practical systems an engineer is likely to encounter.

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### Learning outcome

The learner will:

- 1 understand RACHP system selection and application.

### Assessment criteria

The learner can:

- 1.1 identify heat load sources in RACHP applications
- 1.2 identify heat load data from external information sources
- 1.3 calculate heat loads found in RACHP applications
- 1.4 select and apply RACHP systems for calculated load

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### Range

- (AC1.1) **Heat load sources:** Building fabric, solar, air changes, infiltration, respiration, occupancy, product load, lighting, machinery, equipment, ventilation, temperature, humidity, activity
- (AC1.1, **Applications:** space heating and/or cooling for human comfort
- AC1.3) Chill and/or frozen storage and display  
Chill and /or frozen processing
- (AC1.4) **Select and apply:** RACHP systems (Single Stage)  
Compressor, condenser, expansion valve, evaporator, suction and liquid risers

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### Learning outcome

The learner will:

- 2 understand RACHP systems efficiencies

## Assessment criteria

The learner can:

- 2.1 plot on a pressure enthalpy chart the cooling cycle for RACHP systems
  - 2.2 manipulate pressure enthalpy chart data for system problem solving
  - 2.3 compare system efficiencies at identical operating conditions
  - 2.4 evaluate methods for improving system efficiencies
  - 2.5 compare systems performance for a range of alternative refrigerants (same compressor displacement).
- 

## Range

- (AC2.1) **RACHP systems:** Single stage system including cascade using a range of refrigerants including zeotropes, heat pump system using air, ground and water as a heat source
- (AC2.2) **Problem solving:** CoP (cooling and heating), motor input power, refrigerant quality, mass flow rates for given capacities, volume flow rates through compressor, changing suction and/or discharge pressure, changing suction temperature
- (AC2.3) **System efficiencies:** Single stage, two stage and cascade/compound
- (AC2.3) **Operating conditions:** Saturated suction -40°C, condensing temperatures +40°C
- (AC2.4) **Methods:** Heat recovery, sub-cooling, super heat control, pressure ratio control, capacity control, reduce temperature difference, insulation, frosting, oil circulation.
- 

## Learning outcome

The learner will:

- 3 understand relationship between psychrometric properties and RACHP system performance.

## Assessment criteria

The learner can:

- 3.1 explain the effects of RACHP processes on the properties of air
  - 3.2 manipulate psychrometric data for system problem solving
  - 3.3 optimise plant performance using psychrometric data
- 

## Range

- (AC3.1) **RAC and HP processes:** Sensible cooling, latent cooling, sensible heating, latent heating, air mixing
- (AC3.2) **Problem solving:** Mixed air, off coil conditions, apparatus dew point, coil contact factor, sensible heat ratio, room ratio line, supply air temperature, cooling and heating capacity
- (AC3.3) **Plant performance:** varying air flow rate (mass flow rate of air x enthalpy change) = (AUtd) = (mass flow rate of refrigerant x enthalpy change)
-

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## Learning outcome

The learner will:

- 4 understand requirements for RACHP systems equipment.

## Assessment criteria

The learner can:

- 4.1 select refrigerants for RACHP systems
- 4.2 select equipment for RACHP systems based on regulatory impact
- 4.3 evaluate the Total Environmental Warming Impact (TEWI) for RAC HP systems.

---

## Range

(AC4.1) **Select refrigerants:** Application, performance, cost, environmental impact, hazard class

(AC4.2) **Regulatory impact:** BSEN378, DSEAR, environmental regulations

(AC4.3) **Systems:** RACHP applications

## Unit 302

## Complex RACHP systems

<b>Unit level:</b>	Level 3
<b>GLH:</b>	69
<b>Unit aim:</b>	The purpose of this unit is to provide learners with the understanding of complex RAC HP system components and their interrelationship for a range of applications. Learners will understand the construction and design of a range of system types operating on common refrigerants.

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### Learning outcome

The learner will:

- 1 Understand selection requirements for a range of complex RACHP system components

### Assessment criteria

The learner can:

- 1.1 select suitable components for use with a range of RACHP systems
- 1.2 compare and contrast system designs for a range of refrigerants

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### Range

- (AC1.1) **RACHP systems:** Direct expansion, flooded, pump overfeed, cold store, chill store, water chiller, VRF/VRV air conditioning, ground and air source heat pump, cascade, compound, transcritical, absorption, booster
- (AC1.1) **Components:** Compressors, condensers, evaporators, expansion devices, intercoolers, surge drums, liquid pumps
- (AC1.2) **Range of refrigerants:** HC, HFC, HFO, R717, R744.

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### Learning outcome

The learner will:

- 2 Understand system design for complex RACHP systems.

### Assessment criteria

The learner can:

- 2.1 select system layout for a range of RACHP applications
- 2.2 explain pipework requirements for a range of RACHP applications

- 2.3 select suitable secondary refrigerants for a range of applications
  - 2.4 explain system requirements for systems using secondary refrigerants.
- 

### Range

- (AC2.1) **Applications:** Direct expansion, flooded, pump overfeed, cold store, chill store, water chiller, VRF/VRV air conditioning, ground and air source heat pumps, cascade, compound, transcritical
  - (AC2.2) **Pipework requirements:** Oil return, pressure drop, suction and liquid risers, oil trapping, insulation, fixings, orientation, jointing methods, fittings
  - (AC2.3) **Secondary refrigerants:** Propylene and ethylene glycols, metallic salts in solution, water, alcohols
  - (AC2.4) **Requirements:** Mixing tanks, concentrators, reverse return piping, pumps, flow control valves, temperature, materials suitability for application, concentration testing
- 

### Learning outcome

The learner will:

- 3 Understand how systems are controlled in complex RACHP systems

### Assessment criteria

The learner can:

- 3.1 explain system control strategies for complex systems
  - 3.2 assess suitability of control and monitoring systems for different complex systems
  - 3.3 compare defrost methods for complex systems
  - 3.4 select system controls for a range of complex systems
  - 3.5 explain capacity control systems for complex systems
- 

### Range

- (AC3.2) **Control and monitoring systems:** BMS, EMS, local, remote
- (AC3.3) **Defrost methods:** Electric, reverse cycle, water/brine spray, hot gas, saturated gas, off cycle
- (AC3.4) **Complex systems:** Direct expansion, flooded, pump overfeed, cold store, chill store, water chiller, VRF/VRV air conditioning, dampers, AHUs, ground and air source heat pump

## Unit 303

# Commissioning and troubleshooting complex RACHP systems

<b>Unit level:</b>	Level 3
<b>GLH:</b>	71
<b>Unit aim:</b>	This unit will give the learner the understanding and practical skills to carry out commissioning and troubleshooting activities on complex RACHP systems. Troubleshooting activities are based on systems that have already been commissioned and are in operation.

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### Learning outcome

The learner will:

- 1 Understand requirements for commissioning complex RACHP systems.

### Assessment criteria

The learner can:

- 1.1 identify key commissioning requirements for a range of systems
- 1.2 select equipment required for commissioning a range of systems
- 1.3 explain deviances between actual and design conditions on a range of systems
- 1.4 identify commissioning data required to meet industry standard.

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### Range

(AC1.1) **Key commissioning requirements:** Regulatory, BSEN378, contractual specification

(AC1.2) **Range of systems:** DX multi evaporator, flooded and pump overfeed, compound, cascade and transcritical, VRF (2 and 3 pipe) air conditioning, heat pump systems, secondary cooling circuits

(AC1.4) **Industry standard:** EN378, best practice, manufacturers' requirements

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### Learning outcome

The learner will:

- 2 Be able to commission complex RACHP systems.

### Assessment criteria

The learner can:

- 2.1 record commissioning data
  - 2.2 evaluate system performance from commissioning data
  - 2.3 adjust systems to give design performance
- 

### Range

(AC2.1, **Commissioning data:** Superheat, subcooling, coil approach, airflow, air distribution, air on and off temperatures, oil pressure, system pressures, running current, relative humidity, primary and secondary flow rates.  
AC2.2)

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### Learning outcome

The learner will:

- 3 Be able to troubleshoot complex RACHP systems.

### Assessment criteria

The learner can:

- 3.1 identify system faults using a range of information
  - 3.2 rectify faults in complex systems
  - 3.3 document troubleshooting activities.
- 

### Range

(AC3.1) **Range of information:** Commissioning data, manufacturers manuals, system data, design capacity  
(AC3.2) **Faults:** Refrigerant side, air/secondary side, electrical, control function.



## Unit 304

## Work planning and organisation for RACHP systems

<b>Unit level:</b>	Level 3
<b>GLH:</b>	30
<b>Unit aim:</b>	This unit has been designed to give students a broad understanding of organisations and work planning techniques. It is case study based using real companies so knowledge gained will be relevant and offer knowledge and understanding applicable to career progression.

---

### Learning outcome

The learner will:

- 1 Know how different organisations are structured.

### Assessment criteria

The learner can:

- 1.1 describe how organisations are structured
- 1.2 describe the main business function of the organisation
- 1.3 illustrate the task orientated reporting structure
- 1.4 state the organisational goals
- 1.5 describe how individuals contribute to the organisational goals

---

### Range

(AC1.1) **Structured:** Private limited company, public limited company, partnership, sole trader

(AC1.2) **Main business function:** Maintenance and servicing, manufacturing, commissioning, installation, design

(AC1.4, **Organisational goals:** Mission statement, strategic objectives.

AC1.5)

---

### Learning outcome

The learner will:

- 2 Understand work planning processes.

### Assessment criteria

The learner can:

- 2.1 explain how competent planning contributes to organisational goals
  - 2.2 explain how resource management affects efficiency
  - 2.3 use planning tools to meet organisational requirements
  - 2.4 explain how projects can deviate from plans
  - 2.5 explain when a work delay should be compensated
  - 2.6 describe the importance of contracts.
- 

### Range

- (AC2.1) **Organisational goals:** Profit, growth, liquidity, corporate social responsibility
- (AC2.2) **Resource:** Manpower, machinery / equipment, subcontractors, suppliers, clients
- (AC2.3) **Planning tools:** Simple time / task, Gantt chart, Ishikawa (fish bone), critical path analysis, risk analysis, SWOT.
- (AC2.3) **Organisational requirements:** Contractual obligations, client expectations, profit margins, reputation, performance
- (AC2.4) **Deviate:** Manpower, deliveries, subcontractors, faults, priority changes
- (AC2.5) **Work delay:** Deliveries, subcontractors, equipment faults, client induced, services
- (AC2.6) **Contracts:** Liquidated damages, variations, rise and fall, verbal and written.

## Unit 305

## Electrical power and control for RACHP systems

<b>Unit level:</b>	Level 3
<b>GLH:</b>	156
<b>Unit aim:</b>	This unit develops in learners the understanding of three phase electrical circuits and their control. Learners will apply their understanding by developing skills required to construct electrical circuits appropriate to RACHP systems

---

### Learning outcome

The learner will:

- 1 Understand the fundamental principles of three phase supply used in RACHP systems

### Assessment criteria

The learner can:

- 1.1 explain the fundamental principles of three phase supply
- 1.2 explain how three phase supply is protected.

---

### Range

(AC1.1) **Principles of three phase supply:** a.c, frequency, phase angle, current, voltage, transforming potential, line and neutral, power, power factor

(AC1.2) **Protected:** MCB, fuse, thermal overload, isolator, phase failure, phase rotation.

---

### Learning outcome

The learner will:

- 2 Understand the principles of three phase electric motors

### Assessment criteria

The learner can:

- 2.1 explain the principles of three phase motors
- 2.2 explain starting arrangements for three phase motors
- 2.3 explain the protection arrangements for three phase motor starting arrangements
- 2.4 explain monitoring arrangements of electric motors.

---

### Range

- (AC2.1) **Principles of three phase motors:** Rotation, frequency, magnetic field, winding connections, Star, Delta, part-wind
- (AC2.2, AC2.3) **Starting arrangements:** Direct Online (Star, Delta) Star-Delta, part-wind, soft start, variable speed drive (VSD).
- (AC2.4) **Monitoring arrangements:** Current transformers, phase rotation, ammeters, tachometer, power.
- 

### Learning outcome

The learner will:

- 3 Understand control circuitry

### Assessment criteria

The learner can:

- 3.1 explain relationship between power and control circuits
- 3.2 explain purpose of control circuits
- 3.3 explain control of three phase circuits using a range of voltages
- 3.4 explain control circuit protection methods
- 

### Range

- (AC3.2) **Purpose:** Demand led, protection led
- (AC3.3) **Voltages:** 400, 230, below 50 (ac and dc)
- (AC3.4) **Protection methods:** Fuse, MCB, thermal.
- 

### Learning outcome

The learner will:

- 4 Be able to construct and fault find electrical circuits

### Assessment criteria

The learner can:

- 4.1 construct and fault find electrical circuits
- 4.2 safely isolate electrical circuit
- 4.3 inspect and test electrical circuits
- 

### Range

- (AC4.1, AC4.2) **Electrical circuits:** Control circuit, power circuit
-

(AC4.3) **Inspect and test:** Visual inspection, earth continuity, circuit continuity, insulation resistance, polarity, functional test.

## Appendix 1 Relationships to other qualifications

### ***Links to other qualifications***

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

### ***Literacy, language, numeracy and ICT skills development***

This [these] qualification[s] can develop skills that can be used in the following qualifications:

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

## 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](http://www.cityandguilds.com).

*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 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:** how to register for e-assessments.

*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.



## Appendix 3 Useful contacts

### UK learners

General qualification information

E: [learnersupport@cityandguilds.com](mailto:learnersupport@cityandguilds.com)

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### International learners

General qualification information

E: [intcg@cityandguilds.com](mailto:intcg@cityandguilds.com)

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### Centres

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

E: [centresupport@cityandguilds.com](mailto:centresupport@cityandguilds.com)

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### 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

E: [singlesubjects@cityandguilds.com](mailto:singlesubjects@cityandguilds.com)

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### International awards

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

E: [intops@cityandguilds.com](mailto:intops@cityandguilds.com)

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### Walled Garden

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

E: [walledgarden@cityandguilds.com](mailto:walledgarden@cityandguilds.com)

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### Employer

Employer solutions, Mapping, Accreditation, Development Skills, Consultancy

E: [business@cityandguilds.com](mailto:business@cityandguilds.com)

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As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

## City & Guilds Group

The City & Guilds Group is a leader in global skills development. Our purpose is to help people and organisations to develop their skills for personal and economic growth. Made up of City & Guilds, City & Guilds Kineo, The Oxford Group and ILM, we work with education providers, businesses and governments in over 100 countries.

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