

Level 3 Award in Basic Mobile Air Conditioning Systems (7543-01)

Level 3 Award in Diagnosis and Repair of Mobile Air Conditioning/Climate Control Systems (7543-02)

November 2018, Version 1.4



Qualification at a glance

Subject area	Vehicle Maintenance and Repair
City & Guilds number	7543
Age group approved	16+
Entry requirements	There are no entry requirements
Assessment	Practical assignments and oral questioning (graded Pass)
Fast track	Not available; automatic approval applies in some cases
Support materials	Centre handbook Assessment guides for each unit
Registration and certification	See Online Catalogue/Walled Garden for last dates.

Title and level	GLH	TQT	City & Guilds number	Accreditation number
Level 3 Award in Basic Mobile Air Conditioning	30	30	7543-01	500/3336/0
Level 3 Award in Diagnosis and Repair of Mobile Air Conditioning/Climate Control Systems	40	40	7543-02	500/3337/2

Version and date	Change detail	Section
1.3 September 2017	Added TQT details Deleted QCF	Qualification at a glance, Structure Throughout
1.4 November 2018	Amended unit 003 typo	Throughout

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1 Introduction

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

Area	Description
Who are the qualifications for?	The qualification is for those who are already practicing in the industry, for those whose aim is to enter the industry and for those wanting to gain a certificate for their own personal skills development.
What do the qualifications cover?	<p>These qualifications in Mobile Air Conditioning can be a first step into the vehicle-based air conditioning sector. It also helps people already working in the sector further develop their skills and get an acknowledgement of what they already offer.</p> <p>As part of the qualification you gain a licence to handle refrigerants in compliance with EU regulations (EC) 307/2008. You also learn about the underlying principles and mechanics of air conditioning.</p>
Are the qualifications part of a framework or initiative?	Unit 001 Handle Refrigerants is the licence to practice. This unit can be completed alone as part of the licence to practice requirement without completing the whole qualification which will give a certificate of unit credit.

2 Structure

These qualifications replace the City & Guilds Level 3 Certificate in Mobile Air Conditioning Systems which closes for registration on 31/12/2011.

The mapping between the two qualifications is as follows:

Unit	7543	5101
Handle refrigerants	001	301
Basic Mobile air conditioning Principles	002	302
Diagnosis and repair of complex faults in mobile Air Conditioning Systems/Climate Control Systems	003	303

Full qualification certificates will be awarded to successful candidates on completion of the required combinations of units. Candidates completing one or more units, rather than the full qualification(s), will receive a Certificate of Unit Credit (CUC).

Qualification	Total credits	Credits from mandatory units
City & Guilds Level 3 Award in Basic Mobile Air Conditioning (7543-01)	3	001, 002
Level 3 Award in Diagnosis and Repair of Mobile Air Conditioning/Climate Control Systems (7543-02)	4	003

Before undertaking unit 003 candidates **must** have completed the Handle Refrigerants unit or hold an equivalent qualification in handling refrigerants

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
R/501/2950	7543-001	Handle Refrigerants	1
D/501/2949	7543-002	Basic Mobile Air Conditioning Principles	2
Y/501/3064	7543-003	Diagnosis and repair of complex faults in mobile air conditioning systems / climate control systems	4

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 Award in Basic Mobile Air Conditioning	30	30
Level 3 Award in Diagnosis and Repair of Mobile Air Conditioning/Climate Control Systems	40	40

3 Centre requirements

Approval

Centres already approved to offer the City & Guilds Level 3 Certificate in Mobile Air Conditioning Systems will be automatically approved to register and certificate candidates on the 7543 (unless the centre is already subject to sanctions).

For all other cases, centres will need to gain both centre and qualification approval. Please refer to the *Centre guide* and *Providing City & Guilds Qualifications* for further information.

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

Physical resources and site agreements

Centres must have access to sufficient equipment in the college, training centre or workplace to ensure candidates have the opportunity to cover all of the practical activities.

Suggested equipment list for centres

- Safety equipment/PPE
- Refrigerant identifier (optional but desirable).
- Either a refrigerant management station or a portable recovery/recharging station which includes respective service couplings and hoses
- Manifold gauge set
- Deep vacuum pump
- Oil separator/filter
- Lubricant oil injector
- Refrigerant recovery unit
- Charging cylinder (source cylinder) and scales
- Recovery cylinder
- Flushing kit
- Suitable leak detection equipment
- Electronic leak detector
- Ultra violet lamp and dye kit
- Bubble spray or ultrasonic leak detector
- Oxygen free nitrogen pressure testing kit
- Electronic thermometer
- Multimeter
- Oscilloscope
- Break out kit
- Manufacturers technical data
- Vehicle body protection kits
- training aids/models/example components

Centre staffing

Trainers/learning providers should be technically competent in the areas in which they are delivering training and should also have experience of providing training. This will be looked for at the approval stage and will be monitored by the external verification process.

Assessors/Tutors should have at least two years recent relevant experience in the specific area they will be assessing. If this experience is part-time it should be over a period of five years. They will also be required to meet the requirements of the European legislation on fluorinated gases, if they are using or supervising refrigerant handling. This entails possessing appropriate certification based on completion of any of the following recognised qualifications:

In-house qualification (ie manufacturer training)

City & Guilds (5101 (any single unit), 4101-55, 4100, 3791 ((complexes 10, 11, 12), 6048).

Some IMI qualifications are also recognised.

BAGMA (www.bagma.com) is recognised by City & Guilds as a centre able to offer instructor/assessor training for mobile air conditioning.

A full listing of all acceptable qualifications and self-certification forms can be found in the RMIF publication "Mobile Air Conditioning", published July 2007 (Part No 3500-025) and available from Autoclimate (www.autoclimate.com). It should be noted by centres that the self-certification capability is a time limited transitional process. By 4 July 2010 (provisionally), assessors/tutors will have to meet national certification requirements.

Assessors need to have a greater level of experience and understanding than those they are assessing.

In addition, assessors must demonstrate the ability to mark assignments using externally set criteria.

While the EMPNTO A/V Units are valued as a qualification they are not currently a requirement for assessors of these qualifications.

If a candidate's work is selected for external verification, samples of work must be available to the appointed External Verifier.

An External Verifier will visit the centre/learning provider and their role includes the following:

- ensuring that Quality Assurance Co-ordinators 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 centre's/learning provider's assessment systems.

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

Continuing professional development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Candidate 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.

Please note that for funding purposes, candidates should not be entered for a qualification of the same type, content and level as that of a qualification they already hold.

Age restrictions

The Level 3 Award in Basic Mobile Air Conditioning (7543-01) and the Level 3 Award in Diagnosis and Repair of Mobile Air Conditioning/Climate Control Systems (7543-02) are only approved for candidates aged 16+.

4 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 qualification.
- any units they have already completed, or credit they have accumulated which is relevant to the qualification.
- 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, 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
Centre handbook	www.cityandguilds.com/automotive
Assessment guides for each unit	www.cityandguilds.com/automotive

5 Assessment

Assessment of the qualification

City & Guilds has produced assessment guidance for each unit which can be found at www.cityandguilds.com/automotive.

Each assessment guidance contains:

- specific assessment guidance for assessors – this information must not be divulged to candidates
- marking criteria – this information can be divulged to candidates
- candidate's instructions – assignment specific
- knowledge questions – this information may only be asked orally and the answers may not be divulged prior to the assessment.

Candidates will expect a reasonable amount of guidance on how to organise themselves in order to

- accomplish tasks
- check their level of underpinning knowledge prior to assessment.

Assessors are strongly advised to check and familiarise themselves with the requirements and workability of each assignment before it is issued to candidates. It is recommended that assessors produce a worked copy of the practical tests that their candidates are undertaking.

Whatever method assessors use to ensure quality checks are taking place, please send a copy of your proposed system to your External Verifier.

Candidates should only have access to the materials as specified in the assessment guidance notes and should not be permitted to take in their class notes. However, for some of the assessments it may be necessary for candidates to have access to manufacturer's manuals and on-line help facilities.

Grading of assignments is Pass or Fail. The pass mark for each unit is set at 60%.

Grading is based on essential and desirable criteria for each task. Each marking criterion should be marked with a 'P' to indicate achievement and a cross 'X' if it has not been achieved. In the event that a marking criterion is not applicable, it should be crossed through and marked 'not appropriate' and a note made of the reason(s) why. Candidates must achieve all essential and a prescribed number of desirable criteria for the award of a Pass. Detailed marking criteria are provided for each assignment in the Marking Criteria section of the assignments.

The criteria for individual tasks in the assignments do not appear in the instructions for candidates.

To complete any part of this qualification, learners must successfully undertake both the practical and oral assessment. If a candidate fails any part of the unit being assessed, they must repeat the task; however, assessors should allow seven days before any re-assessment

Time constraints

Recommended time allowances have been allocated for each assessment; however, this does not form part of the marking criteria, and is for guidance purposes only.

Should assessors find that the recommended time for an assignment is considerably at a variance with the time taken by candidates, they should contact their External Verifier in the first instance, who will advise accordingly and feed this information back to City & Guilds where appropriate.

Keeping records

The candidate's records that the centre must hold as required for regulatory compliance purposes must include:

- candidate name
- date of birth
- particular assessment requirements
- workplace
- assessor(s) name
- Quality Assurance Co-ordinator/scheme co-ordinator's name
- date of registration
- candidate enrolment number
- award title and level
- progress records, including unit accreditation and award completion dates.

The assessment records that the centre must hold for 5 years as required for regulatory compliance purposes include:

- name of the candidate
- units/components assessed, types of evidence submitted and assessment methods used
- names of each assessor involved with the units/components
- dates on which the assessments took place
- assessment locations
- assessment decisions made
- assessment plans, review and feedback records, assessment judgments.

6 Units

Structure of units

These units each have the following:

- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- GLH
- Relationship to EU legislations
- Assessment requirements specified by a sector or regulatory body
- learning outcomes which are comprised of a number of assessment criteria
- Supporting information

Summary of units

City & Guilds unit number	Unit title	Unit accreditation number (UAN)
7543-001	Handle Refrigerants	R/501/2950
7543-002	Basic Mobile Air Conditioning Principles	D/501/2949
7543-003	Diagnosis and repair of complex faults in mobile air conditioning systems/climate control systems	Y/501/3064

Unit 001

Handle Refrigerants

UAN:	R/501/2950
Level:	3
Credit value:	1
GLH:	10
Relationship to EU legislations:	This unit meets the minimum requirements of Regulation (EC) 307/2008).
Assessment requirements specified by a sector or regulatory body:	As far as possible this unit should be assessed in a workplace environment. Assessment methods should be appropriate to reflect the level of the unit and should assess both the candidates understanding and ability to demonstrate skills.

Learning outcome	The learner will:
1	Understand how to handle refrigerants.
Assessment criteria	
The learner can:	
1.1	Interpret legislative and organisational requirements and procedures relevant to workplace practices whilst handling refrigerants.
1.2	Explain the operating principles and functional requirements of Mobile Air Conditioning systems and components.
1.3	Compare the types of refrigerants; their properties, characteristics and the associated environmental issues.
1.4	Explain the use and application of special purpose tools, equipment and materials needed for system recovery, vacuum, recharging, flushing (if applicable), and leak detection for Mobile Air Conditioning systems.
1.5	Explain procedures for handling refrigerant and minimising refrigerant losses and emissions.

Learning outcome	The learner will:
2	Handle refrigerants.
Assessment criteria	
The learner can:	
2.1	Work safely, complying with Health & Safety and other relevant regulations and manufacturer guidelines.
2.2	Identify the system refrigerant type and act in accordance with legislation and operating procedures.
2.3	Demonstrate the ability to use the tools and equipment required, throughout activities for recovery, vacuum testing, recharging and, flushing (if applicable), and the ability to carry out at least two methods of leak detection.
2.4	Correctly store and transfer waste material following current legal requirements.
2.5	Complete records accurately, and pass to the relevant person(s) promptly in the format required and in accordance with any legal requirements..

Unit 001 Handle Refrigerants

Supporting information

Unit range

Legislative and organisational requirements

- a) current EC regulations on fluorinated gases The provisions of Regulation (EC) No 842/2006 and Directive 2006/40/EC
- b) current EC regulations on certain Ozone depleting gases
- c) environmental protection act 1990, section 33 and 34, safe and legal disposal of waste materials, waste transfer note , d)
- d) management of HSE at work regulations,
- e) control of substances hazardous to health regulations C.O.S.H.H
- f) Health and Safety at Work act
- g) EC waste regulations.

Operating principles and functional requirements of Mobile Air Conditioning systems and components

- a) functions of the systems
- b) methods of heat transfer
- c) difference between heat and temperature
- d) meaning of latent heat and sensible heat
- e) definition of terms pressure, gauge, pressure, compound, atmospheric, absolute, pressure / temperature , relationship, vacuum, humidity / relative humidity, compression, condensation, evaporation, units of measurement
- f) refrigeration cycle – compression, condensation, evaporation
- g) refrigerant state and condition - saturated vapour, superheated vapour, sub-cooled liquid
- h) refrigerant systems – refrigerant circuits – txv & fot
- i) refrigerant systems – compressor, condenser, expansion valves, fixed orifice tube, receiver drier, suction accumulator and evaporator
- j) lubrication - types (mineral oils and pag), viscosity (all levels), quantities.

Refrigerants

Types of refrigerant R12 (CFC), properties, characteristics, R134a (HFC), properties, characteristics, hydrocarbons, risks (flammability), blends (drop-ins), risks (fractionation).

Environmental issues

- a) ozone layer
- b) ozone depletion
- c) greenhouse effect
- d) climate change and global warming
- e) Montreal protocol
- f) Kyoto agreement.

Special purpose tools, equipment and materials needed for system recovery, vacuum, recharging, flushing (if applicable), and leak detection for Mobile Air Conditioning systems

- a) service equipment and hand tools - purpose and operation
- b) goggles & gloves
- c) refrigerant identifiers *
- d) refrigerant recovery unit *
- e) service couplings and hoses *
- f) manifold gauge set *
- g) recovery cylinder
- h) charging cylinder (or scale) for measuring refrigerant qty *
- i) leak detection

* Items marked maybe incorporated into a Refrigerant Management Station (RMS)

Procedures for handling refrigerant and minimising refrigerant losses and emissions.

- a) refrigerant identification, refrigerant recovery, charge completion for a source cylinder, final leak checking*
* Leak detection visual, electronic
- b) disposal, recycling or destruction of waste refrigerants
- c) Health and Safety/environmental requirements for handling, storage and transportation of refrigerants

Unit 002

Basic Mobile Air Conditioning Principles

UAN:	D/501/2949
Level:	3
Credit value:	2
GLH:	20
Assessment requirements specified by a sector or regulatory body:	<p>As far as possible this unit should be assessed in a workplace environment.</p> <p>Assessment methods should be appropriate to reflect the level of the unit and should assess both the candidates understanding and ability to demonstrate skills.</p> <p>Before undertaking this unit candidates must have completed the Handle Refrigerants unit.</p>

Learning outcome	The learner will:
1	Understand and comply with responsibilities and requirements when carrying out activities in a work situation.
Assessment criteria	
The learner can:	
1.1	Interpret legislative, regulatory and organisational requirements and procedures relevant to workplace practices.
1.2	Work safely, complying with Health & Safety and other relevant regulations and manufacturer guidelines.
1.3	Explain personal and vehicle protection when servicing Mobile Air Conditioning systems.
1.4	Demonstrate the use of vehicle coverings when handling refrigerants, flushing and servicing mobile air conditioning systems.
1.5	Work in a way which minimises the risk of damage to other vehicles, components and units.
1.6	Describe your workplace procedures for recording rectification activities (including leak detection), the location of faults, the referral of problems and reporting delays to the completion of work.
1.7	Analyse the importance of reporting anticipated delays to the relevant person(s) promptly.
1.8	Store and dispose of any waste material following current legal and environmental requirements.

Learning outcome	The learner will:
2	Understand basic mobile air conditioning principles.
Assessment criteria	
The learner can:	
2.1	Explain the operation and function of refrigerant systems and components - refrigerant circuits – thermal expanse valve & fixed orifice tube, compressor, compressor clutch, refrigerant pipes and hoses, condenser, evaporator (single & dual systems), thermostatic expansion valve, fixed orifice tube, suction accumulator, receiver drier, pressure switches – binary, trinary & clutch cycling, thermostats – electrical & mechanical, electrical circuit.

2.2	Evaluate how the following controls and components affect the performance of the Mobile Air Conditioning system – thermal expanse valve & fixed orifice tube, driver controls, a/c switch, recirculation switch, fan control switch, air distribution.
2.3	Explain the service procedures for Mobile Air Conditioning systems and the use of specific tools and equipment for system recovery, vacuum, recharging, flushing (if applicable), service and maintenance of Mobile Air Conditioning systems.

Learning outcome	The learner will:
3	Apply basic mobile air conditioning principles.
Assessment criteria	
The learner can:	
3.1	Use tools and equipment, correctly and safely throughout all recovery, vacuum and, recharging and flushing activities (if applicable).
3.2	Evaluate system performance prior to and post servicing activities.
3.3	Carry out all rectification activities following manufacturer instructions, your workplace procedures and any health and safety requirements
3.4	Carry out a minimum of two methods of leak detection -ultraviolet, visual, electronic, oxygen free nitrogen - on mobile air conditioning systems.
3.5	Check that all repaired and replaced components and units conform with the vehicle operating specification and any legal requirements.
3.6	When necessary, adjust components and units correctly to ensure that they operate to meet system requirements.
3.7	Complete all system recovery, vacuum, recharging, flushing (if applicable) and leak detection activities within the agreed timescale.
3.8	Produce records identifying deviations and refrigerant types which are accurate, complete and passed to the relevant person(s) promptly in the format required and in accordance with any legal requirements.

Unit 002 Basic Mobile Air Conditioning Principles

Supporting information

Unit range

Legislative, regulatory and organisational requirements and procedures

- a) The Health and Safety legislation, workplace procedures relevant to workshop practices whilst handling refrigerants, personal vehicle protection when carrying out rectification activities.
- b) Your workplace procedures for recording fault location, rectification activities the, referral of problems and reporting delays to the completion of work.
- d) The importance of working to agreed timescales and keeping others informed of progress.
- e) The relationship between time, costs and profitability.
- f) The importance of reporting anticipated delays to the relevant person(s) promptly
- g) Refrigerant systems: refrigerant circuits:
 - i) txv & fot
 - ii) compressor
 - iii) compressor clutch
 - iv) refrigerant pipes and hoses
 - v) condenser
 - vi) evaporator (single & dual systems)
 - vii) thermostatic expansion valve
 - viii) fixed orifice tube
 - ix) suction accumulator
 - x) receiver drier
 - xi) pressure switches – binary, trinary & clutch cycling
 - xii) thermostats – electrical & mechanical, electrical circuit.
- h) Configuration:
 - i) fot & txv
 - ii) driver controls
 - iii) a/c switch
 - iv) recirculation switch
 - v) fan control switch
 - vi) air distribution.

Service equipment and hand tools

- a) purpose and operation
- b) goggles and gloves
- c) refrigerant identifiers *
- d) refrigerant recovery unit *
- e) service couplings and hoses *
- f) manifold gauge set *
- g) vacuum pump *
- h) lubricant oil injector *
- i) charging cylinder (source cylinder), (scale) for measuring refrigerant qty *
- j) temperature measuring equipment *

- k) leak detection
- l) visual (oil trace and bubble spray)
- m) electronic (corona discharge & heated diode)
- n) ultrasonic
- o) ultra violet
- p) oxygen free nitrogen (ofn)
- q) belt tensioning gauge
- r) air flow meters
- s) refrigerant flushing equipment *.

* Items marked may be incorporated into a Refrigerant Management Station (RMS)

Service procedures

- a) Refrigerant identification, initial system evaluation – testing, pressure, temperature, air distribution & speed, refrigerant recovery, system evacuation, vacuum check, adding oil, initial charging, leak detection, visual, electronic, ultrasonic, ultra violet, oxygen free nitrogen, charge completion, final leak checking, final system evaluation – testing, pressure, temperature, air distribution and speed.
- b) System flushing.

Unit 003

Diagnosis and Repair of Complex Faults in Mobile Air Conditioning / Climate Control Systems

UAN:	Y/501/3064
Level:	3
Credit value:	4
GLH:	40
Assessment requirements specified by a sector or regulatory body:	<p>As far as possible this unit should be assessed in a workplace environment.</p> <p>Assessment methods should be appropriate to reflect the level of the unit and should assess both the candidates understanding and ability to demonstrate skills.</p> <p>Before undertaking this unit candidates must have completed the Handle Refrigerants unit or hold an equivalent qualification in handling refrigerants</p>

Learning outcome	The learner will:
1. Understand and comply with responsibilities and requirements when carrying out activities in a work situation.	
Assessment criteria	
The learner can:	
1.1	Interpret legislative, regulatory and organisational requirements and procedures relevant to workplace practices.
1.2	Carry out out all diagnostic and rectification activities following manufacturer instructions, your workplace procedures, health and safety and other regulations and guidelines.
1.3	Wear suitable personal protective equipment and use vehicle coverings when handling refrigerants, servicing air conditioning systems, flushing, diagnosing and carrying out rectification activities.
1.4	Work in a way which minimises the risk of damage to other vehicles, damage to other components and units, contact with leakages, contact with hazardous substances, any refrigerant emissions and personal or third party injury.
1.5	Dispose of any waste material following current legal and environmental requirements.
1.6	Explain the importance of working to agreed timescales, keeping others informed of progress and documenting diagnostic and rectification information.
1.7	Ensure your records identifying deviations and refrigerant types are accurate, complete and passed to the relevant person(s) promptly in the format required and in accordance with any legal requirements.

Learning outcome	The learner will:
2. Understand how to diagnose and repair complex faults in mobile air conditioning systems/climate control systems.	
Assessment criteria	
The learner can:	
2.1 Explain operating principles of air conditioning and climate control systems.	
2.2 Describe the operating principles and functional requirements for mobile air conditioning and climate control components.	
2.3 Explain the methods of accessing the relevant data from the utilisation of information sources.	
2.4 Describe how to prepare the systems and components for diagnosis and rectification.	
2.5 Describe common air conditioning system and component faults.	
2.6 Explain how to diagnose faults using appropriate diagnostic techniques – gauge pressure interpretation, system diagnostics and repair procedures - for both TXV & FOT air conditioning systems.	
2.7 Describe the methods used in the removal, refitting and maintenance of air conditioning components.	
2.8 Describe how to prepare and use hand, special purpose tools, equipment and materials needed to remove and refit systems and components.	
2.9 Describe common climate control system and component faults.	
2.10 Describe appropriate component fault finding techniques for climate control systems.	
2.11 Describe the methods used in the removal, refitting and maintenance of climate control system components.	

Learning outcome	The learner will:
3. Diagnose and repair complex faults in mobile air conditioning systems/climate control systems.	
Assessment criteria	
The learner can:	
3.1 Demonstrate the identification of complex faults, repair systems and components on mobile air conditioning and climate control systems by reviewing vehicles; technical data and diagnostic test procedures using servicing/testing and diagnostic techniques which are relevant to the symptoms presented, for either TXV or FOT systems.	
3.2 Prepare, connect and test all the required air conditioning equipment/special purpose tools following manufacturers' instructions prior to use and use the tools and equipment required, correctly and safely throughout all diagnostic and rectification activities.	
3.3 Collect sufficient diagnostic information in a systematic way, via gauge pressure interpretation system diagnostics and repair procedures, to enable an accurate diagnosis of mobile air conditioning and climate control faults for either TXV or FOT systems.	
3.4 Make cost effective recommendations for rectification based upon your analysis of the diagnostic information gained.	
3.5 Ensure all repaired and replaced components and units conform to the vehicle operating specification and any legal requirements.	
3.6 When necessary, adjust components and units correctly to ensure that they operate to meet system requirements.	
3.7 Complete all system diagnostic activities within the agreed timescale.	
3.8 Prior to handing the vehicle over to the customer, ensure that the a/c system performs to vehicle operating specifications and any other legal requirements.	

Unit 003 **Diagnosis and Repair of Complex Faults in Mobile Air Conditioning / Climate Control Systems**

Supporting information

Unit range

Legislative and organisational requirements and procedures:

- a) the Health and Safety legislation and workplace procedures relevant to workshop practices whilst handling refrigerants, personal and vehicle protection when diagnosing, rectifying complex faults and components in Mobile Air Conditioning and climate control
- b) the workplace procedures for recording fault location, rectification of complex faults and the referral of problems reporting delays to the completion of work
- c) the importance of documenting diagnostic and rectification information
- d) the importance of working to agreed timescales and keeping others informed of progress whilst diagnosing complex faults

Operational function of the climate control system

- a) manual temperature control - air distribution, windscreen, face, foot, rear temperature (heating, cooling), air speed (manual (stepped and variable), recirculation, manual operation air conditioning, mode (on / off), economy (ec), defrost / demist, manual
- b) semi automatic temperature control - air distribution (windscreen, face, foot, rear, temperature, heating, cooling, air speed manual (stepped and variable), automatic, recirculation, (manual operation, automatic operation, air conditioning) mode,(on / off, economy (ec), automatic, defrost/demist), manual
- c) automatic temperature control - air distribution (windscreen, face, foot, rear), temperature (heating, cooling), air speed, manual (stepped and variable), automatic, recirculation, manual operation, automatic operation, pollution control, defrost/demist, air conditioning, mode (on/off, economy (ec), automatic (auto), rest), defrost / demist (manual, zoning), driver, passenger, rear, single evaporator, dual evaporator.

Principles of operation, purpose, construction, diagnosis, removal, refitting and maintenance of Mobile Air Conditioning and climate control components

- a) compressor clutches - types and drives, a-groove, polyvee, overhang, alignment, electrical connections
- b) compressors – types, piston, axial, reciprocating, swash / wobble plate, radial, scroll, rotary vane, variable, piston, scroll, mounting, direct, ear, control devices, mechanical control valve, thermal switches, high pressure relief valves, super heat and thermal limiters, maintenance and repair, clutch air gap (adjustment), clutch removal and refitting, shaft seal replacement, hygroscopic, checking levels
- c) hoses and pipes – sizes, types of fittings, flare, o ring, block / pad, spring-lock, construction, materials, rubber, aluminium, steel
- d) mufflers
- e) service valves and ports - flare type, back seating valve, quick couplers
- f) condenser - purpose, construction and operation, tube and fin, serpentine, parallel flow, sub-cooled, fans, maintenance, inspection and cleaning
- g) dehydrators - purpose, construction and operation, receiver driers, accumulator, desiccant bag
- h) metering devices - purpose, construction and operation, thermal expansion valve, internally equalised, externally equalised, block, fixed orifice tube (fot)

- i) evaporators - purpose, construction and operation, fin and tube, serpentine, plate and fin, maintenance, treatments (odour and bacterial), pollution/pollen filters
- j) electrical control devices - purpose, construction and operation, pressure switches, binary, trinary, clutch cycling, thermostats, electrical and mechanical
- k) retrofitting – procedures, effects on components, o rings, compressors, lubricants, hose and pipes, condensers, dehydrators and desiccant, metering devices, labelling, service ports, electrical control devices

Methods of accessing the relevant data from the utilisation of information sources:

- a) describe the methods of accessing data - workshop manuals, manufacturers data and information sheets, service schedules, parts lists, trade association check lists, legal and technical data reference books
- b) state how to access data using – computers, microfiche.

Diagnose faults via gauge pressure interpretation, system diagnostics and repair procedures for both txv and fot air conditioning systems

- a) fault finding via gauge pressure interpretation - txv system (high pressure, low pressure), fot system (high pressure, low pressure, compressor cycle times)
- b) system diagnostics (characteristic system faults) – situations, metering devices, thermal expansion valve, (txv stuck in open position, txv stuck in closed position), orifice tube, leaking, blocked
- c) control devices – thermostat, mechanical problem, electrical problem, pressure switches (all types), malfunctions, refrigerant (undercharged system, overcharged system, moisture, air), refrigerant system restrictions (receiver drier, accumulator, blocked condenser), compressors (noisy, overcharged system, undercharged system, lack of lubrication, belt tension and condition, pulley alignment, mounting, damaged valves), reduced air flow (internal (interior , pollution / pollen filter, blocked evaporator, fan resistor), external (exterior - blocked condenser, faulty condenser fan), hvac control mechanisms, recirculation flap, air distribution flaps, water valves, temperature control, water ingress (blocked or incorrectly routed evaporator drain tubes, hvac casings), vehicle odours (evaporator, bacteria).

Air conditioning components

- a) compressor
- b) pipes and hoses
- c) condenser
- d) condenser fans
- e) dehydrator
- f) receiver drier
- g) accumulator
- h) metering devices
- i) thermal expansion valve
- j) fixed orifice tube
- k) evaporator
- l) control devices
- m) pressure switches
- n) thermostats
- o) control valves.

Diagnostic tools

- a) multimeter
- b) oscilloscope

- c) fault codes
- d) diagnostic (Self)
- e) code reader
- f) break out box
- g) manufacturer specific.

Methods used in the removal, refitting and maintenance of climate control system components

- a) control – temperature control units - semi automatic, input, output, automatic, input, output
- b) sensors (operation, purpose and construction), in-vehicle temperature , ambient temperature, evaporator temperature, coolant temperature, solar load, position (flaps and valves), air quality, vehicle speed, pressure switches, compressor (anti-lock)
- c) actuators (operation, purpose and construction), mechanical, temperature blending, air distribution, fresh air/recirculation, idle up, electrical, temperature blending, air distribution, fresh air/recirculation, idle up
- d) valves – water, single, dual, liquid refrigerant valve
- e) blowers (fans), heater motor, condenser fan.

Climate control systems, configurations, operations and components including diagnosis

- a) climate control – function, heat loads, comfort zone, pollution
- b) climate control system configurations manual temperature control air distribution, temperature, air speed, recirculation, air conditioning, defrost / demist
- c) semi automatic temperature control - air distribution, temperature, air speed, recirculation, air conditioning, defrost / demist
- d) automatic temperature control - air distribution, temperature, air speed, recirculation, air conditioning, defrost / demist.



Appendix 1 Relationships to other qualifications

Links to other qualifications

Mapping is provided as guidance and suggests areas of commonality between the qualifications. It does not imply that candidates completing units in one qualification have automatically covered all of the content of another.

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

These qualifications can develop skills that can be used in the following qualifications:

Functional Skills (England) – see www.cityandguilds.com/functionalskills

Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni

Essential Skills Wales (from September 2010).



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 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:** how to register for e-assessments.

Useful contacts

UK learners

General qualification information

E: learnersupport@cityandguilds.com

International learners

General qualification information

E: intcg@cityandguilds.com

Centres

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

E: centresupport@cityandguilds.com

Single subject qualifications

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

E: singlesubjects@cityandguilds.com

International awards

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

E: intops@cityandguilds.com

Walled Garden

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

E: walledgarden@cityandguilds.com

Employer

Employer solutions, Mapping,
Accreditation, Development Skills,
Consultancy

E: business@cityandguilds.com

Publications

Logbooks, Centre documents,
Forms, Free literature

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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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