**SQA/SNIJIB**

# Training and Assessment Programme for SVQ level 3 Domestic Plumbing and Heating

## Unit F9HD 04: Emergent Technologies Combined Option (Section 1 + 2 out of 3 Technologies to be covered)

# Introduction

This Unit covers the emergent technologies requirement of the Plumbing and Heating SVQ 3.

It is in four sections:

1 Working Principles, Installation Options and Regulatory Requirements for Micro-Renewable Technologies, Water Harvesting and Recycling Technologies
2 Solar Thermal Domestic Hot Water
3 Heat pumps
4 Grey water, Rainwater Harvesting/Grey Water reuse.

Acceptable performance in this Unit will be the satisfactory achievement of Section 1 plus two of the three optional sections to the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

# Learning and delivery guidance

The scope of this Unit is as set out below. Delivery of this Unit to a group of candidates will involve many teaching and learning techniques and approaches.

It is essential that teaching and learning takes place in an environment where candidates experience working with Micro Renewable Installations.

The use of modern teaching and learning aids (ie ‘smart boards’, etc) and proprietary interactive teaching materials would also greatly enhance the learning experience.

Accreditation of Prior learning. Candidates will have covered some of the subject area in earlier units. Lecturers may decide not to cover this again. However they should ensure that the candidates still retain the knowledge as it will be assessed in the SOLAR e-assessment.

# Assessment

A holistic approach has been adopted for the summative aspects of the practical installation part of this Unit.

The TAP contains practical tests.

Assessments other than practical assessments will be undertaken using SQA's SOLAR e-assessment method. This process is completed entirely online and randomly selects the assessment questions from a bank of questions, which cover the Knowledge content in this Unit. There is one SOLAR e-assessment for each section over the year of the Unit's duration. (Refer to programme structure in the Introduction. The practical assessments may be spread over the year although it would be beneficial to carry out the assessments after achieving the knowledge.

Where practical assessments require the candidate to identify or recognise faulty or otherwise, systems, components, hazards, or equipment the assessor must complete model answers prior to assessment. These should be retained for internal and external verification purposes.

All installations must be protected by either a 30 mA RCD or RCBO which should be tested to a regular maintenance programme.

<table>
<tr><th colspan="3">Emergent Technologies — Overview Section 1 (mandatory) + two from the other three</th></tr>
<tr><td>Section 1<br>Working Principles, Installation Options and Regulatory requirements for Micro-Renewable Technologies, Water Harvesting and Recycling Technologies</td><td colspan="2">ET 1.1<br>Identify the fundamental working principles of micro-renewable and water harvesting and recycling technologies.<br>ET 1.2<br>Identify the typical advantages and disadvantages of micro-renewable and water harvesting and recycling technologies.<br>ET 1.3<br>Identify the fundamental requirements of building location/building features for potential to install micro-renewable and water cycling to exist.</td></tr>
<tr><td>Section 2<br>Install Test, Commission and Handover Solar Thermal Hot Water Systems. Inspect Service and Maintain Solar Thermal Hot Water Systems</td><td>Section 3<br>Install Test, Commission and Handover Heat Pump Systems. Inspect, Service Ground and Air Source Heat Pump Systems</td><td>Section 4<br>Install Test, Commission and Handover Rainwater Harvesting/Grey water Reuse Systems</td></tr>
<tr><td>ET 2.1<br>Identify and describe the requirements to install, commission and handover solar thermal hot water systems.<br>ET 2.2<br>Install, test, commission and handover solar thermal hot water systems.<br>ET 2.3<br>Describe and identify the requirements to inspect, service and maintain ‘active’ solar thermal hot water systems.<br><br>ET 2.4<br>Inspect, service and maintain solar thermal hot water systems.</td><td>ET 3.1<br>Identify and describe the requirements to install, test, commission and handover heat pump systems.<br><br>ET 3.2<br>Install, test, commission and handover heat pump systems.<br><br>ET 3.3<br>Identify and describe the requirements to inspect, service and maintain heat pump system installations.<br>ET 3.4<br>Identify and describe the requirements to install, test, commission and handover heat pump systems.</td><td>ET 4.1<br>Know the requirements to Install, commission and handover rainwater harvesting and grey water reuse systems.<br>ET 4.2<br>Install, test, commission and handover rainwater harvesting and grey water reuse systems.<br>ET 4.3<br>Know the requirements to inspect, service and maintain rainwater harvesting and grey water reuse systems.<br>ET 4.4<br>Inspect, service and maintain rainwater harvesting and grey water re use systems.</td></tr>
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The above programme must meet the micro generation certification scheme installation standards.

# Syllabus

## Section 1 Working Principles, Installation Options and Regulatory Requirements for Micro-Renewable Technologies, Water Harvesting and Recycling Technologies

### ET 1.1

Identify the fundamental working principles of micro-renewable and water harvesting and recycling technologies.

(a) Identify the fundamental working principles for each of the following heat producing micro-renewable energy technologies solar thermal (hot water), ground source heat pump, air source heat pump and biomass.
(b) Identify the fundamental working principles for each of the following electricity producing micro-renewable energy technologies solar photovoltaic, micro-wind, micro-hydro.
(c) Identify the fundamental working principles for each of the following water harvesting and recycling technologies rainwater harvesting and grey water recycling.
(d) Identify the fundamental working principles of the following co-generation technologies micro-combined heat and power.

### ET 1.2

Identify the typical advantages and disadvantages of micro-renewable and water harvesting and recycling technologies.

(a) Identify typical advantages associated with each of the following technologies listed in the range statement.
(b) Identify typical disadvantages associated with each of the following technologies listed in the range statement.

**RANGE STATEMENT**

- solar thermal (hot water)
- solar photovoltaic
- ground source heat pump
- air source heat pump
- micro-wind
- biomass
- rainwater harvesting
- grey water recycling
- micro-hydro
- micro-combined heat and power (heat-led)

## ET 1.3

Identify the fundamental requirement of building location/building features for potential to install micro-renewable and water recycling systems to exist.

(a) Identify the fundamental requirements for potential to install a solar water heating system to exist.
(b) Identify the fundamental requirements for potential to install a solar photovoltaic system to exist.
(c) Identify the fundamental requirements for potential to install ground source heat pumps system to exist.
(d) Identify the fundamental requirements for potential to install an air source heat pump system to exist.
(e) Identify the fundamental requirements for potential to install a biomass system.
(f) Identify the fundamental requirements for potential to install a micro wind system.
(g) Identify the fundamental requirements for potential to install a micro hydro system.
(h) Identify the fundamental requirements for potential to install a water harvesting or recycling system.
(i) Identify the fundamental requirements for potential to install a microcombined heat and power (heat led) system.

## ET 1.4

Identify the fundamental regulatory requirements relating to micro-renewable and water harvesting and water recycling technologies.

(a) Identify what would be typically classified as ‘permitted development’ under town and country planning regulations in relation to the deployment of the following technologies listed in the range statement.
(b) Identify which sections of the current building regulations/building standards apply in relation to the deployment of the following technologies listed in the range statement.

### RANGE STATEMENT

- solar thermal (hot water)
- solar photovoltatic
- ground source heat pump
- air source heat pump
- micro-wind
- biomass
- rainwater harvesting
- grey water recycling
- micro-hydro
- micro-combined heat and power (heat-led)

### EVIDENCE REQUIREMENTS

This will be evidenced by SOLAR e-assessment.

# Syllabus

## Section 2 Install, Test, Commission and Handover Solar Thermal Hot Water Systems. Inspect, Service and Maintain Solar Thermal Hot Water Systems

### ET 2.1

Identify and describe the requirements to install, commission and handover solar thermal hot water systems.

### ET 2.2

Install, test, commission and handover solar thermal hot water systems.

### ET 2.3

Describe and identify the requirements to inspect, service and maintain ‘active’ solar thermal hot water systems.

### ET 2.4

Inspect, service and maintain solar thermal hot water systems.

## ET 2.1

Identify and describe the requirements to install, commission and handover solar thermal hot water systems.

Take relevant precautionary actions to minimise the risk of injury to self or others during the fault rectification work.

(a) Identify the health and safety risks and safe systems of work associated with solar thermal hot water system installation work.
(b) Identify the requirements of relevant regulations/standards relating to practical installation, testing and commissioning activities for solar thermal hot water system installation work.
(c) Describe the types and layouts of solar thermal hot water system that incorporate a sealed collector circuit.
(d) Describe the purpose of components used within solar thermal hot water system installations.
(e) Identify and describe the types and key operating principles of solar collectors.
(f) Identify the information requirements to enable system component selection and sizing.
(g) Identify the fundamental techniques used to select, size and position components for solar thermal hot water systems.
(h) Describe how the performance of solar hot water systems is measured.
(i) Identify the preparatory work required for solar thermal hot water system installation work.
(j) Describe the requirements for connecting solar thermal hot water system collector circuits to combination boiler domestic hot water circuits.
(k) Identify the requirements for installing solar collector arrays.
(l) Identify the requirements for installing for solar thermal hot water system pipework.
(m) Identify the requirements to test and commission solar thermal hot water system installations
(n) Identify the requirements to handover solar thermal hot water systems.

### RANGE STATEMENT

(a) Identify which aspects of solar thermal hot water system installation work pose risk of:

- electrocution/electric shock
- burns
- toxic poisoning
- injury through flash to steam of system heat transfer fluid
- a fall from height
- personal injury though component/equipment handling

Propose safe systems of work for solar thermal hot water system installation work in relation to prevention of:

- electrocution/electric shock
- burns
- toxic poisoning
- injury through flash to steam of system heat transfer fluid
- a fall from height
- personal injury though component/equipment handling

(b) Interpret current building regulation/building standards guidance documentation as relevant to solar thermal hot water system installation work to identify the requirements in relation to:

- maintaining the structural integrity of the building
- maintaining the fire resistant integrity of the building
- the prevention of moisture ingress (building water tightness)
- notification of work requirements
- control of temperature in primary and secondary circuits including primary circuits connected to unvented hot water storage systems
- energy conservation
- testing and commissioning requirements
- compliance certification

Interpret current industry recognised water regulation/byelaw guidance documentation as relevant to solar thermal hot water system installation work to identify the requirements in relation to:

- prevention of contamination of the wholesome water supply
- energy conservation
- safe operation
- testing and commissioning requirements

(c) Identify the following indirect solar thermal hot water systems types:

- Fully filled (active)
- Drainback (active)
- Passive (thermosiphon)

Identify the following solar thermal hot water system storage vessel types and arrangements:

- Indirect, sealed collector circuit, Domestic Hot Water storage cylinder only (solar primary coil only)
- Indirect, sealed collector circuit, Domestic Hot Water storage cylinder only (dual coil)
- Indirect, sealed collector circuit, pre-heat cylinder and Domestic Hot Water storage cylinder
- Indirect, sealed collector circuit, thermal store

(d) Explain the purpose of the following solar thermal hot water system components:

- Differential temperature controller
- Cylinder sensor(s)
- Solar collector sensor
- Drain back vessel
- Flow meter
- Flow regulator (mechanical)
- Expansion vessel

(e) Identify the following types of solar collector:

- unglazed collector
- flat plate glazed collector
- roof integrated glazed collector
- evacuated tube collector — direct flow
- evacuated tube collector — heat pipe

Explain the key operating principles for:

- flat plate collectors
- evacuated tube collector — direct flow
- evacuated tube collector — heat pipe

Determine the effect that the temperature difference between the solar primary circuit/collector temperature and the ambient temperature has on the relative efficiency of the following types of solar collector:

- unglazed collector
- flat plate glazed collector
- evacuated tube collector

(f) Identify the information requirements in relation to:

- building design
- building dimensions/angles
- building location and orientation
- building fabric/material details
- existing input services
- existing hot water/heating systems

Explain the requirements of information in relation to:

- building occupancy
- required hot water usage pattern

(g) Explain how to determine typical domestic hot water system storage vessel requirements in relation to:

- Daily demand (Vd) (litres/day per person or litres/day per $m^2$ of floor area)
- Boiler volume (Vb)
- Dedicated solar volume (Vs) (litres per $m^2$ of collector area or as a % or Vd)
- Total cylinder volume (Vt)
- Solar heat exchange coil surface area ($m^2$ of surface area in relation to collector flow rate and collector surface area)

Explain how to determine the annual irradiation yield as a % of optimum in relation to:

- collector orientation
- collector angle
- collector over shading

Explain recommended solar primary circuit circulation rates.

Explain how to determine solar primary circuit pipe size requirements in relation to:

- primary circuit circulation rates
- collector area
- primary circuit pipework length

Explain how to determine total solar primary circuit water content volume.

Explain how to determine total solar primary circuit expansion vessel size requirements in relation to:

- primary circuit water content volume
- collector height above cylinder

Explain typical sizing requirements for drainback vessels in relation to:

- net collector area
- total volume of the system

Explain how to determine solar primary circuit dynamic pressure drop and circulating pump size requirements for:

- fully filled systems
- drainback systems

(h) Define the meaning of the term ‘solar fraction’.

Identify factors that affect the solar fraction.

(i) State the requirements in relation to:

- authorisation for the work to proceed
- the availability of appropriate access to all required work areas

Explain the requirements of pre-installation checks in relation to:

- the suitability of the proposed location and position of the solar collector(s) for optimum collection capacity
- the suitability of the building structure and the building fabric in relation to the installation of system components
- verification that the generation capacity of the proposed solar hot water system installation is appropriate to the hot water system energy load and usage
- the inspection of existing hot water/heating system installations
- water quality
- the availability of a suitable electrical input service
- the proposed siting of key internal system components

(j) Explain how to determine the suitability of combination boilers to receive preheated water.

Explain the pipework layout and components required for connecting a solar thermal hot water system to a combination boiler to include the:

- arrangements for prevention of backflow
- arrangements for ensuring that the combination boiler cold inlet supply water is provided at an appropriate temperature
- arrangements for allowing stored hot water to be used directly from the store when the temperature of the stored water is appropriate

(k) Explain the positioning and fixing requirements and where appropriate the weathering requirements for the following solar collector types:

- Flat plate, surface mounted, inclined roof with single lap roof covering
- Flat plate, surface mounted, inclined roof with double lap roof covering
- Flat plate, integrated, inclined single lap roof covering
- Flat plate, integrated, inclined double lap roof covering
- Evacuated tube, inclined single lap roof covering
- Evacuated tube, inclined double lap roof covering
- Frame mounted, inclined (roof, wall or ground)
- Frame mounted, horizontal (roof or ground)

Explain the pipework layout, component requirements and component positioning requirements for the following system types and collector array connection arrangements:

- fully filled system, collector array connected in series
- fully filled system, collector array connected in parallel
- fully filled system, collector array connected with east/west split
- drainback system, single collector array

Explain the requirements to achieve durable weather-tightness of buildings where collector array connection pipework passes through the building fabric.

State when specialist equipment is required in relation to preventing irradiation reaching collector absorbers during installation.

(l) Propose suitable pipework materials in relation to:

- system operating temperatures
- system operating pressures
- system chemicals

Explain the requirements for pipework supports:

- suitable materials
- spacing of pipework supports

Propose suitable pipework jointing methods in relation to:

- system operating temperatures
- system operating pressures
- system chemicals

Explain the requirements for pipework insulation for solar thermal hot water system installation work in relation to:

- system operating temperatures
- system efficiency and performance
- potential exposure of the insulation to ultra-violet rays/light
- potential exposure of the insulation to adverse weather
- the sections of installations that must be insulated
- the sections of installations that must not be insulated

Explain the requirements for installing pressure relief valve discharge pipework:

- routing of pipework
- termination of pipework

(m) Explain the requirements to prepare for testing and commissioning in relation to:

- compliance with the system design and specification
- compliance with system/component manufacturer requirements
- suitability of electrical supply circuit arrangements
- flushing the system of installation debris
- selection of suitable heat transfer fluid
- filling and venting the hydraulic circuits
- checking system water quality
- protection against freezing
- provision of system labelling

State what specialist equipment is required in relation to:

- the introduction and checking of system freeze protection fluids
- setting system pressure
- checking the corrosion protection of the system

Explain the testing requirements for hydraulic circuits within solar thermal hot water system installations in relation to:

- hydraulic test pressure
- hydraulic test duration

Explain the commissioning requirements for a fully-filled indirect sealed collector circuit installation in relation to:

- setting of the expansion vessel charge pressure
- setting of the system fluid level
- setting of mechanical controls
- setting of electrical controls and temperature sensors
- system functional tests

Explain the commissioning requirements for a fully-filled drainback installation in relation to:

- setting of the system fluid level
- setting of mechanical controls
- setting of electrical controls and temperature sensors
- system functional tests

Explain the commissioning requirements for multiple collector arrays connected in series.

State the recording requirements for the commissioning of solar thermal hot water system installations.

(n) Explain the pre-handover checks that need to be carried out.

Explain industry handover procedures in relation to the:

- provision of written information
- provision of diagrammatic information
- provision of verbal information/demonstration relating to system operation and use

**EVIDENCE REQUIREMENTS**

This will be evidenced by SOLAR e-assessment.

## ET 2.2

Install, test, commission and handover solar thermal hot water systems.

### PERFORMANCE CRITERIA

(a) Plan and prepare for the installation of 'active' solar thermal hot water system.
(b) Install key solar thermal hot water system components.
(c) Test and commission an 'active' solar thermal hot water system.
(d) Handover an 'active' solar thermal hot water system.

### RANGE STATEMENT

(a) Undertake pre-installation checks for a solar hot water system installation to include checks relating to:

- ♦ authorisation for the work to proceed
- ♦ verification that the generation capacity of the proposed solar hot water system installation is appropriate to the hot water system load
- ♦ the availability of appropriate access to all required work areas
- ♦ the inspection of existing hot water/heating system installations
- ♦ the availability of a suitable electrical input service
- ♦ the proposed siting of key internal system components
- ♦ the suitability of the building structure in relation to the proposed installation
- ♦ the suitability of the proposed location and position of the solar collector panel(s) for optimum collection capacity
- ♦ the suitability of the building fabric in relation to the installation of the solar collector panel(s)

Confirm that the tools, materials and equipment required for the installation work are available and are in a safe usable condition.

(b) Install in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures, key system components on either a fully-filled or drainback 'active' solar thermal hot water system to include as a minimum the positioning, fixing and connection of the following components:

Fully-filled systems:

- ♦ Solar collector
- ♦ Expansion vessel
- ♦ Solar Circulating pump

Drainback systems:

- ♦ Solar collector
- ♦ Drainback vessel
- ♦ Solar Circulating pump

(c) Prepare a fully-filled or drainback solar thermal hot water system for testing and commissioning to include checks/actions to confirm:

- compliance with the system design and specification
- compliance with system/component manufacturer requirements
- the suitability of electrical supply circuit arrangements
- correct flushing the system of installation debris
- correct filling and venting the hydraulic circuits
- protection of the system against freezing
- adequate provision of system labelling

Test the system for hydraulic soundness using appropriate test equipment in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures.

Identify the commissioning requirements for the installation in relation to:

- the system/component manufacturer(s) requirements
- system design/specification requirements
- the client/end user requirements
- statutory regulations and/or industry recognised procedures

Commission a fully-filled or drainback system in accordance with manufacturer's guidance, design, client's and statutory requirements and/or industry recognised procedures.

Complete relevant documentation to record the commissioning activities.

Undertake relevant checks to ensure that the system is ready for handover and compliant with manufacturer's guidance, the system design/specification, client's, regulatory and/or industry recognised requirements.

Explain and demonstrate to the end user the operation and use of the system using manufacturer's guidance and industry agreed handover procedures.

Identify and explain to the end user any aspects of the system that varies from the agreed specifications and requirements.

Obtain acceptance by the end user of the system according to the industry agreed handover procedures.

Ensure that all relevant handover documentation is correctly completed and recorded in the appropriate information systems and passed to the end user in accordance with manufacturer's guidance and industry recognised procedures.

**EVIDENCE REQUIREMENTS**

This will be evidenced by practical assessment contained in the appendices for this Unit.

## ET 2.3

Describe and identify the requirements to inspect, service and maintain ‘active’ solar thermal hot water systems.

### PERFORMANCE CRITERIA

(a) Describe the requirements for the routine service and maintenance of ‘active’ solar thermal hot water systems.
(b) Describe how to diagnose faults in ‘active’ solar thermal hot water system installations.
(c) Identify how to rectify ‘active’ solar thermal hot water systems.

### RANGE STATEMENT

(a) Clarify which documentation needs to be available to enable routine service and maintenance work on ‘active’ solar thermal hot water systems.

Clarify typical routine service and maintenance requirements for fully filled systems in relation to:

- visual inspection requirements
- cleaning of components
- checking of system water content
- functional tests

Clarify typical routine service and maintenance requirements for drainback systems in relation to:

- visual inspection requirements
- cleaning of components
- checking of system water content
- functional tests

Explain the industry requirements for the recording and reporting of routine service and maintenance work on solar thermal hot water systems.

(b) Clarify the information that needs to be available to enable fault diagnosis.

(c) Clarify the work action and sequences required to diagnose the following faults:

- loss of system pressure without evidence of discharge
- discharge from pressure relief valve on the solar primary circuit
- insulation melting on solar collector circuit pipework
- overheating of solar collector circuit
- lack of circulation within the solar collector circuit
- poor or no system performance
- system noise and/or vibration

### EVIDENCE REQUIREMENTS

This will be evidenced by SOLAR e-assessment.

## ET 2.4

Inspect, service and maintain solar thermal hot water systems.

### PERFORMANCE CRITERIA

(a) Undertake the routine service and maintenance of an ‘active’ solar thermal hot water system.
(b) Undertake fault diagnosis work on ‘active’ solar thermal hot water system installations.
(c) Undertake fault rectification work on ‘active’ solar thermal hot water system Installations.

### RANGE STATEMENT

(a) Obtain the relevant information required to enable the work.

Undertake a visual service and maintenance inspection of a fully-filled or drainback ‘active’ solar thermal hot water system installation to include checks in relation to:

- compliance with manufacturer’s installation instructions
- compliance with statutory regulations
- condition of system components including cleanliness
- correct positioning of system components
- security of fixing of system components

Undertake routine servicing of relevant components on a fully-filled or drainback ‘active’ solar thermal hot water system to include:

- checking the system water levels
- checking provision for the expansion of system water
- checking for protection of the system water against freezing
- cleaning of system components
- adjustment of system controls

Undertake routine service and maintenance functional tests on a fully-filled or drainback solar thermal hot water system to confirm:

- safe operation
- efficient operation
- the correct functioning of system components/controls

Complete the relevant service and maintenance records in accordance with industry recognised procedures.

(b) Obtain the relevant information required to enable the fault diagnosis work.

Diagnose the cause of a minimum of **four** separate faults from the following list:

- Loss of system pressure without evidence of discharge
- Discharge from pressure relief valve on the solar primary circuit
- Insulation melting on solar collector circuit pipework
- Overheating of solar collector circuit
- Lack of circulation within the solar collector circuit
- Poor or no system performance
- System noise and/or vibration

Agree with the relevant person(s) fault rectification procedures for the faults identified.

(c) Obtain the relevant information required to enable the fault rectification work.

Take relevant precautionary actions to prevent unauthorised use of the system prior to or during the fault rectification work.

Take relevant precautionary actions to minimise the risk of injury to self or others during the fault rectification work.

Rectify a minimum of **two** separate faults from the following list:

- Loss of system pressure without evidence of discharge
- Discharge from pressure relief valve on the solar primary circuit
- Insulation melting on solar collector circuit pipework
- Overheating of solar collector circuit
- Lack of circulation within the solar collector circuit
- Poor or no system performance
- System noise and/or vibration

Undertake post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition.

**EVIDENCE REQUIREMENTS**

This will be evidenced by practical assessment contained in the appendices for this Unit.

# Syllabus

## Section 3

## Install, Test, Commission and Handover Heat Pump Systems

## Inspect, Service Heat Pump Systems

The aim of this section is to allow candidates to develop the knowledge and skills required to install, commission and handover heat pump system installations. The section focuses upon systems up to 45kW load and include air source, water source and ground source systems. The section covers connection to collector loops and the fundamental requirements of collector loop design and installation. However, the section does not cover collector loops installation in detail. The section covers the requirements for appropriate qualifications as required by The Fluorinated Greenhouse Gases Regulations 2008, in relation to heat pump work but the section does not cover aspects of heat pump work that involves handling fluorinated greenhouse gases.

### ET 3.1

Identify and describe the requirements to install, test, commission and handover heat pump systems.

### ET 3.2

Install, test, commission and handover heat pump systems.

### ET 3.3

Identify and describe the requirements to inspect, service and maintain heat pump system installations.

### ET 3.4

Inspect, service and maintain heat pump system installations.

## ET 3.1

Identify and describe the requirements to install, test, commission and handover heat pump systems.

### PERFORMANCE CRITERIA

(a) Identify the health and safety risks and safe systems of work associated with heat pump system installation work (non-refrigerant systems).
(b) Identify the requirements of relevant regulations/standards relating to practical installation, testing and commissioning activities for heat pump installation work.
(c) Identify the components and operational characteristic of heat pump units.
(d) Identify the purpose and operational characteristics of heat pump unit and heat pump system components.
(e) Identify the different types of heat pump units and system arrangements for hydraulic emitter circuits.
(f) Describe the fundamental principles of heat pump selection and system design that are common to both air and ground source heat pumps.
(g) Describe the fundamental design principles for ground source 'closed loop' heat pump collector circuit design and component sizing.
(h) Identify the layouts of 'open loop' water filled heat pump collector circuits.
(i) Describe the fundamental design considerations that are specific to air source heat pumps.
(j) Identify the preparatory work required for heat pump installation work.
(k) Identify the requirements to install and test heat pump systems.
(l) Identify the requirements to commission heat pump system installations.
(m) Identify the requirements to handover heat pump system installations.

### RANGE STATEMENT

(a) Confirm which aspects of heat pump installation work pose risk of:

- electrocution/electric shock
- burns
- toxic poisoning
- personal injury though component/equipment handling

(b) Interpret building regulation/building standards guidance documentation as relevant to heat pump installation work to identify the requirements in relation to:

- maintaining the structural integrity of the building
- maintaining the fire resistant integrity of the building
- the prevention of moisture ingress (building water-tightness)
- notification of work requirements
- physical installation requirements
- energy conservation
- testing and commissioning requirements
- compliance certification

Interpret industry recognised water regulation/byelaw guidance documentation as relevant to heat pump installation work to identify the requirements in relation to:

- the physical installation of the system
- energy conservation
- safe operation
- testing and commissioning requirements

State the requirements of the current fluorinated greenhouse gases regulations in relation to:

- the competence of personnel installing heat pumps where the refrigerant circuit has been assembled and tested by the product manufacturer
- the competence of personnel installing heat pumps where the refrigerant circuit is to be assembled and tested in the location where the heat pump is to be installed and operated
- the competence of personnel undertaking leakage checking on heat pump refrigerant circuits
- the competence of personnel undertaking recovery of fluorinated greenhouse gases from heat pump refrigerant circuits

(c) Confirm the purpose and operational characteristics of the following components:

- Evaporator
- Low pressure switch
- Compressor
- High pressure switch
- Condenser
- Dryer/receiver
- Sight glass
- Expansion valve
- Expansion valve phial
- Refrigerant four way valve
- Brine pump
- Emitter circuit electromechanical valves
- Fan coil
- Integrated buffer tank
- Ground loop heat exchanger

Confirm the vapour compression refrigerant circuit within a heat pump unit operates.

(d) Recognise the following heat source/heat sink heat pump packages that can be deployed with a hydraulic ‘heat sink’ emitter circuit:

- outside air/water
- exhaust air/water
- brine (closed loop)/water
- water (open loop)/water
- DX (closed loop)/water

Identify the different types of heat pump unit within the categories:

- ground source — packaged (indoor)
- ground source — packaged (outdoor)
- air source — external air, packaged (indoor)
- air source — external air, packaged (outdoor)
- air source — external air, internal heat pump unit with brine circuit between fan coil unit and heat pump unit

Confirm the meaning of the terms:

- monovalent system
- bivalent system

Identify the following monovalent hydraulic emitter circuits:

- heating only
- heating with buffer tank
- heating with buffer tank and indirect stored domestic hot water
- heating with buffer tank and indirect stored domestic hot water with solar coil
- heating with thermal store

Identify the following parallel bivalent hydraulic emitter circuits that incorporate a secondary heat source other than an immersion heater:

- heating with buffer tank
- heating with buffer tank and indirect stored domestic hot water
- heating with buffer tank and indirect stored domestic hot water with solar coil
- heating with buffer tank and thermal store

Confirm the arrangements for connecting buffer tanks:

- in series
- in parallel

(e) Confirm the meaning of the term ‘Coefficient of Performance’.

Confirm the relationship between Coefficient of Performance and the:

- heat pump input temperature
- heat pump emitter temperature

Confirm the effect that ambient temperature can have on:

- coefficient of performance
- heat pump output

Confirm the meaning of the term ‘Seasonal Performance Factor’.

Identify the factors that can affect the Seasonal Performance Factor.

Confirm the meaning of the term ‘System Efficiency’.

Identify the factors that can affect the ‘System Efficiency’.

Confirm why achieving minimum heat loss from the building is particularly important when designing a heat pump system.

State the effect that oversizing and undersizing of a heat pump has on:

- system performance/efficiency
- heat pump operation

Confirm how to identify heat pump hydraulic flow rate requirements.

Confirm how to use manufacturer’s data to select heat pump units:

- output charts
- other data

Confirm the meaning of the term ‘bivalent points’ in relation to heat pump output Charts.

Confirm how ‘bivalent points’ are used to determine auxiliary heat requirements.
Confirm how heat pump output is affected by:

- heat pump input temperature
- heat pump output temperature

Identify the suitability of the following types of hydraulic heating system emitter for suitability with heat pump systems:

- underfloor heating
- fan assisted convector heaters
- standard panel radiators

State the typical mean water temperature recommended when designing a hydraulic emitter circuit that incorporates:

- underfloor heating
- fan assisted convector heaters
- standard panel radiators

Confirm how correction factors are used to determine panel radiator output requirements in relation to mean water temperature and room temperature difference (ºC).

Confirm the potential benefits of including a buffer tank in the system design.
Identify the potential disadvantages of including a buffer tank in the system design.

Confirm the typical allowance in litres (l) per kilowatt (kW) of heat pump output that would be allowed for sizing a buffer tank when there is no requirement for heat during compressor 'off' periods.

Confirm using available external temperature, heat load and system flow temperature data, the required size (heat output in kW) of a heat pump to be connected to a hydraulic heat emitter circuit using a monovalent system design.

State the typical annual operating hours for a heat pump that is being used for:

- heating only
- heating and domestic hot water

State how heat pump annual operating hours may vary in relation to the:

- type of building
- geographical location of the installation

(g) Identify the following brine filled heat pump collector circuit configurations:

- ground 'closed' loop horizontal
- ground 'closed' loop compact collector
- ground 'closed' loop slinky
- ground 'closed' loop vertical borehole
- lake 'closed' loop
- vertical borehole closed' loop

Confirm the requirements of horizontal 'closed' loop brine filled hydraulic heat pump collector circuits in relation to:

- suitable pipework materials
- below ground jointing
- protection against frost damage
- protection against mechanical damage
- separation distances to avoid thermal interference
- separation distances from other services and adjacent buildings
- achieving balanced loop/collector circuits

Confirm the typical requirements of vertical borehole 'closed' loop brine filled hydraulic heat pump collector circuits in relation to:

- suitable pipework materials
- below ground jointing
- protection against frost damage
- protection against mechanical damage
- separation distances to avoid thermal interference
- separation distances from other services and adjacent buildings
- achieving balanced loop/collector circuits

Identify the typical components required in relation to:

- single circuit ‘closed’ loop collector circuits
- multi-circuit ‘closed’ loop collector circuits
- brine circuits between outside air source units and internal heat pump units

Confirm the typical layout of components in relation to:

- single circuit collector circuits
- multi-circuit collector circuits
- brine circuits between outside air source units and internal heat pump units

Confirm which factors determine the year round average energy available in Watts (W) per $m^2$ of ground area.

Confirm how to determine the energy requirement (refrigeration capacity) from the ground loop (kW) using the total heat pump capacity (kW) and the electrical energy input rating (kW).

Confirm how the specific heat extraction capacity (in $W/m^2$ for horizontal/vertical trench collectors and W/m for vertical borehole collectors) of the ground collector circuit can be affected by:

- ground conditions/soil types
- annual heat pump operating hours
- type of backfill material
- geographical location — ground rest temperature
- ground loop configuration

Confirm how the total ground area ($m^2$) requirements for horizontal collector loops is determined using the following data:

- refrigeration capacity (kW)
- specific extraction output ($W/m^2$)

Confirm how the pipe length (m) requirement for a horizontal ‘loop’ collector circuit is determined using the following data:

- total ground area ($m^2$)
- collector loop pipe spacing (m)

Confirm how the pipe length (m) requirement for a ‘slinky’ collector circuit is determined using the following data:

- total ground area ($m^2$)
- centre to centre spacing of the slinky collector (m)

Confirm how the typical collector length (m) requirement for a vertical borehole collector circuit is determined using the following data:

- heat pump refrigeration capacity (kW)
- ground condition
- annual heat pump operating hours

Confirm how a collector circuit brine pump size (Kg/h) is determined using the following data:

- design flow rate
- brine viscosity
- heat pump refrigeration capacity (kW)
- specific thermal capacity of brine (kj/kg)
- temperature difference between brine circuit flow and return pipework (ºC)

(h) Identify the following 'open loop' water filled heat pump collector circuit configurations:

- ground 'open' loop vertical borehole
- lake 'open' loop

(i) Identify the factors that need to be considered when selecting and positioning air source heat pump fan coil units in relation to:

- operating noise (including the potential effect on neighbouring properties)
- air turbulence during operation
- confirm how to size a buffer tank to provide for an air source heat pump defrost cycle

Identify the design options to provide for the defrost cycle for an air source heat Pump.

(j) Confirm the common requirements of pre-installation checks for air or ground source heat pump unit installations connected to hydraulic emitters circuits in relation to:

- authorisation for the work to proceed
- the availability and collation of all relevant information
- verification of the suitability of the hydraulic emitter circuit for connection to the heat pump unit
- verification that the heat output capacity of the heat pump unit is matched to the required proportional contribution of the total building heat load
- verification that the buffer tank sizing correct
- the availability of appropriate access to all required work areas
- the availability and condition of a suitable electrical input service
- adequate provision for the siting of key internal system components
- the suitability of the building structure in relation to the proposed installation

Confirm the pre-installation checks that are specific to the positioning of fan coil units.

(k) Confirm the requirements for moving and handling heat pump units to avoid damage to the unit.

Confirm the requirements to avoid undue noise and or vibration transmission from the heat pump unit to the building structure during the operation of the heat pump.

Identify the requirements where brine circuit pipework passes through the external building fabric in relation to:

- provision for movement
- protection against freezing
- prevention of water ingress
- purging of air and installation debris
- addition of antifreeze protection and suitable biocides
- checking flow rates

State what equipment is needed for system charging and flushing.

Confirm the hydraulic test requirements for:

- closed loop collector circuits
- hydraulic emitter circuits

(l) Confirm the conditions that are required to implement commissioning activities for ground source heat pump systems.

Confirm the commissioning requirements for ground source heat pump systems in relation to:

- setting of mechanical controls
- setting of electrical controls and temperature sensors
- functional tests

Confirm the conditions that are required to implement commissioning activities for air source heat pump systems.

Confirm the commissioning requirements for air source heat pump systems in relation to:

- setting of mechanical controls
- setting of electrical controls and temperature sensors
- functional tests

(m) Confirm the pre-handover checks that need to be carried out for a ground source heat pump system installation.

Confirm the industry handover procedures for a ground source heat pump system installation in relation to the:

- provision of written information
- provision of diagrammatic information
- provision of verbal information/demonstration relating to system operation and use

Confirm the pre-handover checks that need to be carried out for an air source heat pump system installation.

Confirm the industry handover procedures for an air source heat pump system installation in relation to the:

- provision of written information
- provision of diagrammatic information
- provision of verbal information/demonstration relating to system operation and use

**EVIDENCE REQUIREMENTS**

This will be evidenced by SOLAR e-assessment.

## ET 3.2

Install, test, commission and handover heat pump systems.

**PERFORMANCE CRITERIA**

(a) Plan and prepare for the installation of heat pumps (non-refrigerant systems).
(b) Install air and ground source heat pump units.
(c) Test and commission a ground source heat pump installation.
(d) Test and commission an air source heat pump installation.
(e) Handover an air or ground source heat pump installation.

**RANGE STATEMENT**

(a) Undertake pre-installation checks for a heat pump installation to include checks relating to:

- authorisation for the work to proceed
- the availability of appropriate access to all required work areas
- the availability and collation of all relevant information
- verification of the suitability of the proposed location of the fan coil unit (air source heat pumps only)
- verification that the collector circuit is appropriate to the heat pump rating (ground source heat pumps only)
- verification that the heat pump rating is suitable for the emitter circuit load (heating and/or heating and hot water)
- verification of the suitability of the proposed location of the heat pump unit
- verification that the emitter circuit design or existing installation is compatible with the proposed heat pump installation.
- Verification that the buffer tank size (where relevant) is appropriate
- verification of the suitability of the availability of a suitable electrical input service
- the proposed siting of key internal system components
- the suitability of the building structure in relation to the proposed installation

Confirm that the tools, materials and equipment required for the installation work are available and are in a safe usable condition.

(b) Install in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures an air source heat pump to include as a minimum the connection of the heat pump unit to the hydraulic emitter circuit Install in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures a ground source heat pump to include as a minimum the connection of the heat pump unit to the collector circuit.

(c) Prepare a ground source heat pump system for testing and commissioning to include checks/actions to confirm:

- compliance with the system design and specification
- compliance with system/component manufacturer requirements
- the suitability of electrical supply circuit arrangements
- correct flushing the system of installation debris
- correct filling and venting the hydraulic circuits
- protection of the system against freezing

Test the collector circuit for hydraulic soundness using appropriate test equipment in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures.

Identify the commissioning requirements for the installation in relation to:

- the system/component manufacturer(s) requirements
- system design/specification requirements
- the client/end user requirements
- statutory regulations and/or industry recognised procedures

Commission the installation in accordance with manufacturer's guidance, design, client's and statutory and/or industry recognised procedures.

Complete relevant documentation to record the commissioning activities.

(d) Prepare an air source heat pump system for testing and commissioning to include checks/actions to confirm:

- compliance with the system design and specification
- compliance with system/component manufacturer requirements
- the suitability of electrical supply circuit arrangements
- correct flushing the system of installation debris
- correct filling and venting the hydraulic circuits
- protection of the system against freezing

Identify the commissioning requirements for the installation in relation to:

- the system/component manufacturer(s) requirements
- system design/specification requirements
- the client/end user requirements
- statutory regulations and/or industry recognised procedures

Commission the installation in accordance with manufacturer's guidance, design, client's and statutory requirements and/or industry recognised procedures.

(e) Undertake relevant checks to ensure that the system is ready for handover and compliant with manufacturer's guidance, the system design/specification, client's, regulatory and/or industry recognised requirements.

Explain and demonstrate to the end user the operation and use of the system using manufacturer's guidance and industry agreed handover procedures.

Identify and explain to the end user any aspects of the system that varies from the agreed specifications and requirements.

Obtain acceptance by the end user of the system according to the industry agreed handover procedures.

Ensure that all relevant handover documentation is correctly completed and recorded in the appropriate information systems and passed to the end user in accordance with manufacturer's guidance and industry recognised procedures.

**EVIDENCE REQUIREMENTS**

This will be evidenced by practical assessment contained in the appendices for this Unit.

## ET 3.3

Identify and describe the requirements to inspect, service and maintain heat pump system installations

### PERFORMANCE CRITERIA

(a) Identify the requirements for the non-refrigerant circuit routine service and maintenance of heat pump system installations.
(b) Describe how to diagnose faults in heat pump system installations.
(c) Describe how to rectify faults in heat pump system installations.

### RANGE STATEMENT

(a) Confirm which documentation needs to be available to enable routine service and maintenance work on heat pump system installations.

Confirm typical routine service and maintenance requirements for an air source heat pump installation in relation to:

- visual inspection requirements
- cleaning of components
- checking of system water content
- functional tests

Confirm typical routine service and maintenance requirements for a ground source heat pump installation in relation to:

- visual inspection requirements
- cleaning of components
- checking of system water content
- functional tests

Confirm the industry requirements for the recording and reporting of routine service and maintenance work on heat pump system installations.

State the action to take in the event of a failure or suspected failure of the refrigerant circuit and/or a suspected refrigerant circuit defect.

(b) Confirm the information that needs to be available to enable fault diagnosis.

Confirm the work action and sequences required to diagnose the following faults:

- heat pump low pressure trip/alarm activated by a collector circuit malfunction
- heat pump high pressure trip/alarm activated by an emitter circuit malfunction
- poor or no collector circuit performance
- Insufficient heat output to emitter circuit
- domestic hot water heat up is satisfactory but space heating is not operating
- system noise and/or vibration

(c) Confirm the work action and sequences required to rectify the following faults:

- heat pump low pressure trip/alarm activated by a collector circuit malfunction
- heat pump high pressure trip/alarm activated by an emitter circuit malfunction
- poor or no collector circuit performance
- Insufficient heat output to emitter circuit
- domestic hot water heat up is satisfactory but space heating is not operating
- system noise and/or vibration

**EVIDENCE REQUIREMENTS**

This will be evidenced by SOLAR e-assessment.

## ET 3.4

Inspect, service and maintain heat pump system installations.

### PERFORMANCE CRITERIA

(a) Undertake the non-refrigerant circuit routine service and maintenance of an air source heat pump system installation.
(b) Undertake the routine service and maintenance of a ground source heat pump system installation.
(c) Undertake fault diagnosis work on an air or ground source heat pump system installation.
(d) Undertake fault rectification work on an air or ground source heat pump system installation.

### RANGE STATEMENT

(a) Obtain the relevant information required to enable the work.

Undertake a visual service and maintenance inspection of an air source heat pump installation to include checks in relation to:

- compliance with manufacturer's installation instructions
- compliance with statutory regulations
- condition of system components including cleanliness
- checking the system fluid levels
- checking the system pressure levels
- checks to ensure that electrical controls and temperature sensors are set correctly
- leakage and/or dampness
- correct positioning of system components
- pipework insulation is of the correct grade, in good condition and is firmly in place
- provision of information and safety labels
- security of fixing of system components

Undertake routine servicing of relevant components an air source heat pump installation to include checks in relation to:

- checking for protection of the system water against freezing
- cleaning and lubrication of system components
- adjustment of system controls

Undertake routine service and maintenance functional tests on an air source heat pump installation to confirm:

- safe operation
- efficient operation
- the correct functioning of system components/controls
- no undue noise or vibration

Complete the relevant service and maintenance records in accordance with industry recognised procedures.

(b) Obtain the relevant information required to enable the work.

Undertake a visual service and maintenance inspection of a ground source heat pump installation to include checks in relation to:

- compliance with manufacturer's installation instructions
- compliance with statutory regulations
- condition of system components including cleanliness
- checking the system fluid levels
- checking the system pressure levels
- checks to ensure that electrical controls and temperature sensors are set correctly
- leakage and/or dampness
- correct positioning of system components
- pipework insulation is of the correct grade, in good condition and is firmly in place
- provision of information and safety labels
- security of fixing of system components

Undertake routine servicing of relevant components a ground source heat pump installation to include checks in relation to:

- checking for protection of the system water against freezing
- cleaning and lubrication of system components
- adjustment of system controls

Undertake routine service and maintenance functional tests on a ground source heat pump installation to confirm:

- safe operation
- efficient operation
- the correct functioning of system components/controls
- no undue noise or vibration

Complete the relevant service and maintenance records in accordance with industry recognised procedures.

(c) Obtain the relevant information required to enable the fault diagnosis work.

Diagnose the cause of a minimum of **four** separate faults from the following list:

- heat pump low pressure trip/alarm activated by a collector circuit malfunction
- heat pump high pressure trip/alarm activated by an emitter circuit malfunction
- poor or no collector circuit performance
- insufficient heat output to emitter circuit
- domestic hot water heat up is satisfactory but space heating is not operating
- system noise and/or vibration

Agree with the relevant person(s) fault rectification procedures for the faults identified.

(d) Obtain the relevant information required to enable the fault rectification work.

Take relevant precautionary actions to prevent unauthorised use of the system prior to or during the fault rectification work.

Take relevant precautionary actions to minimise the risk of injury to self or others during the fault rectification work.

Rectify a minimum of **two** separate faults from the following list:

- heat pump low pressure trip/alarm activated by a collector circuit malfunction
- heat pump high pressure trip/alarm activated by an emitter circuit malfunction
- poor or no collector circuit performance
- insufficient heat output to emitter circuit
- domestic hot water heat up is satisfactory but space heating is not operating
- system noise and/or vibration

Undertake post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition.

**EVIDENCE REQUIREMENTS**

This will be evidenced by practical assessment contained in the appendices for this Unit.

## Section 4

## Install, Test, Commission — Handover Rainwater Harvesting/Grey water Reuse Systems. Inspect, Service — Maintain Rainwater Harvesting/Grey water Reuse Systems

**ET 4.1**

Know the requirements to Install, commission — handover rainwater harvesting — grey water reuse systems.

**ET 4.2**

Install, test, commission — handover rainwater harvesting — grey water reuse systems.

**ET 4.3**

Know the requirements to inspect, service — maintain rainwater harvesting — grey water reuse systems.

**ET 4.4**

Inspect, service — maintain rainwater harvesting — grey water reuse systems.

## ET 4.1

Know the requirements to Install, commission — handover rainwater harvesting — grey water reuse systems.

### PERFORMANCE CRITERIA

(a) Know the health and safety risks and safe systems of work associated with rainwater harvesting and grey water reuse system installation work.
(b) Know the requirements of relevant regulations/standards relating to practical installation testing and commissioning.
(c) Know the requirements of relevant regulations/standards relating to practical installation, testing and commissioning activities for solar thermal hot water installation work.
(d) Know the types and layouts of rainwater harvesting and grey water reuse system used for single premises installations.
(e) Know the purpose of components used within rainwater harvesting and grey water reuse systems.
(f) Know the information requirements to enable rainwater harvesting and grey water reuse system component selection and sizing.
(g) Know the fundamental techniques used to select, size and position components for a rainwater harvesting and grey water reuse system.
(h) Know options and requirements for the treatment of water in biological, physical, biomechanical and hybrid rainwater harvesting/grey water recycling systems.
(i) Know the preparatory work required for rainwater harvesting and grey water recycling system installation work.
(j) Know the requirements for installing rainwater harvesting and grey water reuse storage tanks.
(k) Confirm the requirements of the connection arrangement where rainwater and grey water overflow and drainage pipework connects to the underground drainage system
(l) Know the requirements to test and commission rainwater harvesting and grey water re-use system installations.
(m) Know the requirements to handover rainwater harvesting and grey water recycling systems.

### RANGE STATEMENT

(a) Confirm which aspects of rainwater harvesting and grey water reuse system installation work pose risk of:

- electrocution/electric shock
- infection
- toxic poisoning
- asphyxiation
- personal injury though
- component/equipment handling

Confirm safe systems of work for rainwater harvesting and grey water reuse system installation work in relation to prevention of:

- Electrocution/electric shock
- Infection
- Toxic poisoning
- Asphyxiation
- Personal injury through component/equipment handling

(b) Interpret building regulation/building standards guidance documentation as relevant to rainwater harvesting and grey water reuse system installation work to identify the requirements in relation to:

- Notification of the work
- Maintaining the structural integrity of the building
- Maintaining the fire resistant integrity of the building
- The prevention of moisture ingress (building water tightness)
- Cold water supply requirements — water quality-water efficiency
- Roof drainage system installation
- Rainwater and grey water storage tank installation
- Compliance certification.

(c) Interpret industry recognised water regulation/byelaw guidance documentation as relevant to rainwater harvesting and grey water reuse system installation work to identify the requirements in relation to:

- notification of the work
- backflow and contamination prevention requirements
- marking and labelling requirements
- use of the harvested/reused water

(d) Identify the following rainwater harvesting systems types:

- gravity supply
- direct pumped
- pumped to storage cistern, gravity distribution

Identify the following grey water reuse system types:

- Direct reuse
- Short retention
- Basic/physical chemical
- Biological
- BIO-mechanical
- Hybrid

Confirm where in system layouts the following backflow prevention arrangements for wholesome back up water supply are required:

- Type AA air gap
- Type AB air gap

(e) Confirm the purpose of the following rainwater harvesting and grey water reuse system components:

- Anti-surcharge valve
- Calmed inlet
- Inlet filter
- Level sensor/float switch module (including pump and air gap)
- Pump control unit
- Expansion vessel (direct systems)
- Water level gauge

(f) Confirm the information requirements in relation to:

- building design
- building dimensions
- building location and orientation
- building fabric/material details
- existing wholesome water supply systems
- existing rainwater and waste water systems
- proposed use of the harvested rainwater/grey water

Know the information requirements to enable rainwater harvesting and grey water reuse system component selection and sizing.

Confirm the information requirements in relation to:

- Building occupancy
- Demand/usage
- Any special features

(g) Confirm how to determine the storage capacity (litres) of a grey water reuse system within a single premises using the simplified approach in relation to:

- Occupancy
- Grey water yield
- Grey water demand/usage

Confirm how to determine the storage capacity (litres) of a rainwater harvesting system within a single premises using the simplified approach in relation to:

- roof plan area (tiled pitched roofs)
- average annual rainfall depth for the location
- building occupancy

Confirm which materials are typically suitable for the manufacture of rainwater harvesting and grey water reuse storage tanks and cisterns.

Confirm the requirements for durability in relation to the materials selected for rainwater harvesting and grey water reuse system tanks and components.

Confirm the design requirements for rainwater harvesting and grey water reuse storage tank/cistern in relation to:

- Prevention of stagnation of the stored water
- Provision of covers and vents
- Prevention of contamination/microbial growth
- Keeping the stored water dark and cold
- Provision and sizing of an overflow
- Prevention of surcharging via overflow pipework
- Termination of overflows from rainwater harvesting storage tanks
- Termination of overflows from grey water reuse storage tanks
- Proximity to trees
- Contaminated ground
- Groundwater levels
- Ground strength and stability
- Proximity to utilities and foundations

Confirm the requirements for durability in relation to the materials selected for rainwater harvesting and grey water reuse system tanks and components.

Confirm the requirements of pump installation within a rainwater harvesting or grey water reuse system in relation to:

- Prevention of dry running
- Prevention of sound and vibration transfer
- Prevention of overheating
- Provision of non-return valves
- Provision of isolating valves
- Provision of pump failure alarm
- Provision of controls
- Provision for monitoring

Confirm which materials are suitable for rainwater harvesting and grey water reuse system collection and distribution pipework and fittings.

Sate typical collection and distribution system pipe sizes for rainwater harvesting and grey water reuse systems between the storage tank and system control unit.

(h) State when the inclusion of a water treatment arrangement in rainwater harvesting and grey water recycling systems:

- is a regulatory requirement
- may be beneficial or good practice

Confirm the working principles of a UV disinfection system.

Confirm the typical installation arrangements for a UV disinfection system in relation to:

- water sample points
- filters
- flow restrictors
- isolation valves

Confirm the options for the chemical treatment of water in rainwater harvesting and grey water recycling systems.

(i) State the requirements in relation to:

- Authorisation for the work to proceed
- The availability of appropriate access to all required work areas

Confirm the requirements of pre-installation checks in relation to:

- the suitability of the proposed installation in relation to:
  - yield
  - usage
- the suitability of the building structure and the building fabric
- in relation to the installation of system components
- the inspection of the existing water supply installation
- the inspection of the existing rainwater and/or grey water installation
- the availability of a suitable electrical input service
- the proposed siting of key internal system components

(j) Confirm the requirements to maintain the structural integrity of the tank if holes need to be cut within a storage tank during the installation process.

Confirm the requirements for mounting and supporting above ground tanks and cisterns.

Know the requirements for installing for rainwater harvesting and grey water recycling system pipework.

(k) Confirm which jointing methods are acceptable for rainwater and grey water pipework collection pipework.

Confirm which jointing methods are acceptable for rainwater and grey water distribution pipework.

(l) Confirm the requirements to prepare for testing and commissioning in relation to:

- compliance with the system design and specification
- compliance with system/component manufacturer requirements
- suitability of electrical supply circuit arrangements
- flushing the system of installation debris
- filling the storage tank
- provision of marking and labelling to system pipework and components

Confirm the testing requirements for hydraulic testing of the distribution system in relation to:

- Test pressure
- Test duration
- Permitted leakage
- Pass criteria.

Confirm the test procedure to check that cross-connections have not been introduced.

Confirm the typical commissioning requirements for a rainwater harvesting system installation in relation to:

- setting of system fluid levels
- setting of mechanical controls
- setting of electrical controls
- system functional checks.
- water quality checks

Confirm the commissioning requirements for a grey water re-use system installation in relation to:

- setting of the system fluid levels
- setting of mechanical controls
- setting of electrical controls
- system functional tests
- water quality checks

State the recording requirements for the commissioning of rainwater harvesting and grey water re-use installations.

(m) Confirm the pre-handover checks that have to be carried out.

Confirm industry handover procedures in relation to the:

- provision of written information
- provision of diagrammatic information
- provision of verbal information/demonstration relating to system operation and use

**EVIDENCE REQUIREMENTS**

This will be evidenced by SOLAR e-assessment.

## ET 4.2

Install, commission and handover rainwater harvesting and grey water reuse systems.

### PERFORMANCE CRITERIA

(a) The candidate will plan and prepare for the installation of rainwater harvesting and grey water reuse systems.
(b) Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition.
(c) Install rainwater harvesting and grey water reuse system components.
(d) Test and commission rainwater harvesting and grey water reuse systems.
(e) handover rainwater harvesting and grey water reuse systems.

### RANGE STATEMENT

(a) Undertake pre-installation checks for a rainwater harvesting or grey water reuse system installation to include checks relating to:

- the suitability of the proposed installation in relation to:
  - yield
  - usage
  - any special features
- the suitability of the building structure and the building fabric in relation to the installation of system components
- the inspection of the existing water supply installation
- the inspection of the existing rainwater and/or grey water installation
- the availability of a suitable electrical input service
- the proposed siting of key internal system components

(b) Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition.

(c) Install in accordance with manufacturer's guidance, regulatory requirements and industry required procedures, key system components on either a rainwater harvesting or grey water reuse system to include as a minimum the positioning, fixing and connection of the following components:

- storage tank (connection to tank only)
- system control unit (water connections only)
- Pump

(d) Prepare a rainwater harvesting or grey water reuse system for testing and commissioning to include checks/actions to:

- confirm compliance with the system design and specification
- confirm compliance with system/component manufacturer requirements
- confirm the suitability of electrical supply circuit arrangements
- flushing the system of installation debris
- filling the storage tank
- confirm the provision of appropriate marking and labelling to system pipework and components

Test a rainwater harvesting or grey water reuse distribution system for hydraulic soundness using appropriate test equipment in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures.

Undertake the relevant test procedure to check that cross-connections have not been introduced.

Identify the commissioning requirements for a rainwater harvesting or grey water reuse installation in relation to:

- The system/component manufacturer(s) requirements
- System design/specification requirements
- The client/end user requirements
- Statutory regulations and/or industry recognised procedures

Commission a rainwater harvesting and grey water reuse system in accordance with manufacturer's guidance, design requirements, client's requirements and statutory requirements and/or industry recognised procedures.

Complete relevant documentation to record the rainwater harvesting or grey water reuse system commissioning activities.

(e) Undertake relevant checks on either a rainwater harvesting or grey water reuse system to ensure that the system is ready for handover and compliant with manufacturer's guidance, the system design/specification, clients requirement's, regulatory requirements and/or industry recognised requirements.

Explain and demonstrate to the end user the operation and use of either a rainwater harvesting or grey water reuse system using manufacturer's guidance and industry agreed handover procedures.

Identify and explain to the end user any aspects of the rainwater harvesting or grey water reuse system that varies from the agreed specification and requirements.

Obtain acceptance by the end user of the rainwater harvesting or grey water reuse system according to the industry agreed handover procedures.

Ensure that all relevant handover documentation is correctly completed and recorded in the appropriate information systems and passed to the end user in accordance with manufacturer's guidance and industry recognised procedures.

**EVIDENCE REQUIREMENTS**

This will be evidenced by practical assessment contained in the appendices for this Unit.

## ET 4.3

Know the requirements to inspect, service and maintain rainwater harvesting and grey water reuse systems.

### PERFORMANCE CRITERIA

(a) know the requirements for the routine service and maintenance of rainwater harvesting and reuse systems
(b) Know how to diagnose faults in rainwater harvesting and grey water reuse systems
(c) Know how to rectify faults in rainwater harvesting and grey water reuse systems

### RANGE STATEMENT

(a) Confirm which documentation needs to be available to enable routine service and maintenance work on rainwater harvesting and grey water reuse systems.

Confirm the typical routine service and maintenance requirements for a rainwater harvesting system in relation to:

- visual inspection requirements
- cleaning of components
- functional tests

Confirm the typical routine service and maintenance requirements for grey water reuse systems in relation to:

- visual inspection requirements
- cleaning of components
- functional tests

Confirm the relevant guideline values for the general monitoring of water quality in rainwater harvesting and grey water reuse systems in relation to:

- dissolved oxygen (stored rainwater)
- suspended solids
- colour
- turbidity
- pH
- residual chlorine
- residual bromine

(b) Confirm the information that needs to be available to enable fault diagnosis.

Confirm the work action and sequences required to diagnose the following faults:

- poor or no flow into storage tank
- system pump fails to operate
- back-up water supply fails to
- operate
- water quality is unacceptable
- undue system noise or vibration

(c) Confirm the work action and sequences required to rectify the following faults:

- poor or no flow into storage tank
- system pump fails to operate
- back-up water supply fails to operate
- water quality is unacceptable
- undue system noise or vibration

**EVIDENCE REQUIREMENTS**

This will be evidenced by SOLAR e-assessment.

## ET 4.4

Inspect, service and maintain rainwater harvesting and grey water re use systems.

### PERFORMANCE CRITERIA

(a) Undertake the routine service and maintenance of rainwater harvesting and grey water reuse systems. Obtain the relevant information required to enable the work.
(b) Undertake fault diagnosis work on rainwater harvesting and grey water reuse systems installations.
(c) Undertake fault rectification work on rainwater harvesting and grey water reuse systems installations.
(d) Undertake post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition.

### RANGE STATEMENT

(a) Obtain the relevant information required to enable the work:

Undertake a visual service and maintenance inspection of a rainwater harvesting or grey water reuse system installation to include checks related to:

- compliance with manufacturer's installation instructions
- compliance with statutory regulations
- condition of system components including cleanliness
- correct positioning of system components

Undertake the routine service and maintenance of rainwater harvesting and grey water reuse systems.

Undertake routine servicing of relevant components on a rainwater harvesting or grey water reuse system to include:

- checking the system water levels
- checking the system water quality
- cleaning of system components
- adjustment of system controls

Undertake routine service and maintenance functional tests on a rainwater harvesting or grey water reuse system to confirm:

- safe operation
- efficient operation
- the correct functioning of system components/controls

(b) Undertake fault diagnosis work on rainwater harvesting and grey water reuse systems installations.

Obtain the relevant information required to enable the fault diagnosis work.

Diagnose the cause of a minimum of **four** separate faults on a rainwater harvesting and/or grey water from the following list:

- poor or no flow into storage tank
- system pump fails to operate
- back-up water supply fails to operate
- water quality is unacceptable
- undue system noise or vibration

Agree with the relevant person(s) fault rectification procedures for the faults identified.

(c) Undertake fault rectification work on rainwater harvesting and grey water reuse systems installations.

Rectify a minimum of **two** separate faults on a rainwater harvesting and/or grey water reuse system from the following list:

- poor or no flow into storage tank
- system pump fails to operate
- back-up water supply fails to operate
- water quality is unacceptable
- undue system noise or vibration

**EVIDENCE REQUIREMENTS**

This will be evidenced by practical assessment contained in the appendices for this Unit.

# Appendix 1: Practical Assessment candidate work sheets

## ET 2.2

Install, test, commission and handover solar thermal hot water system.

All installations must be protected by either a 30 mA RCD or RCBO which should be tested to a regular maintenance programme.

The candidate shall complete the final connections to pre mounted solar collector and its associated hot water cylinder. The candidate should:

(a) Plan and prepare for the installation of ‘active’ solar thermal hot water system.
(b) Install key solar thermal hot water system components.
(c) Test and commission an ‘active’ solar thermal hot water system.
(d) Handover an ‘active’ solar thermal hot water system.

All in accordance PC (a)–(d) above.

# Marking schedule and candidate feedback

## ET 2.2

Install, test, commission and handover solar thermal hot water system.

| **Name:** | | **Class:** | **Date:** |
|---|---|---|---|
| **Result:** | **Assessor:** | | **Date:** |

| **Marking schedule** | **Yes** | **No** |
|---|---|---|
| (a) Plan and prepare for the installation of 'active' solar thermal hot water system. | | |
| (b) Install key solar thermal hot water system components. | | |
| (c) Test and commission an 'active' solar thermal hot water system. | | |
| (d) Handover an 'active' solar thermal hot water system. | | |
| All in accordance with the criteria and range statements contained in the Unit. | | |
| | | |
| Candidate feedback | | |
| Candidate's response | | |
| Candidate's signature Date | | |

**Note to assessor:** Candidate feedback should relate to the PC and knowledge statements above.

# Appendix 1: Practical Assessment candidate work sheets

All installations must be protected by either a 30 mA RCD or RCBO which should be tested to a regular maintenance programme.

## ET 2.4

Inspect, service and maintain solar thermal hot water systems.

**PERFORMANCE CRITERIA**

(a) Undertake the routine service and maintenance of an ‘active’ solar thermal hot water system.
(b) Undertake fault diagnosis work on ‘active’ solar thermal hot water system installations.
(c) Undertake fault rectification work on ‘active’ solar thermal hot water system Installations.

The candidate shall undertake a visual service and maintenance procedure on a working ‘active’ solar thermal hot water system.

The candidate should diagnose the cause of four faults on a working ‘active’ solar thermal hot water system.

The candidate shall identify and repair two faults in an ‘active’ solar thermal hot water system:

The candidate should undertake post-rectification functional tests in accordance with manufacturer’s guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition.

All in accordance with the criteria and range statement contained in the Unit.

# Marking schedule and candidate feedback

## ET 2.4

Inspect, service and maintain solar thermal hot water systems.

| **Name:** | | **Class:** | **Date:** |
|---|---|---|---|
| **Result:** | **Assessor:** | | **Date:** |

| **Marking schedule** | **Yes** | **No** |
|---|---|---|
| (a) Inspection and service is carried out in accordance with the criteria and range statement contained in the Unit. | | |
| (b) The cause of four faults from the list contained in the Unit is diagnosed in accordance with the criteria contained in the Unit. | | |
| Post rectification checks are carried in accordance with the criteria and range statement contained in the Unit. | | |
| (c) Rectify two faults from the list contained in the Unit. | | |
| The candidate should complete post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition. | | |
| Candidate feedback | | |
| Candidate's response | | |
| Candidate's signature Date | | |

**Note to assessor:** Candidate feedback should relate to the PC and knowledge statements contained in the Unit.

# Appendix 1: Practical Assessment candidate work sheets

## ET 3.2

Install, test, commission and handover heat pump systems.

### PERFORMANCE CRITERIA

(a) Plan and prepare for the installation of heat pumps (non-refrigerant systems)
(b) Install air and ground source heat pump units
(c) Test and commission a ground source heat pump installation
(d) Test and commission an air source heat pump installation
(e) Handover an air or ground source heat pump installation

The candidate should make final connections (non-refrigerant systems) to an air and ground source heat pump. All in accordance with PC (a)–(e) above.

## Marking schedule and candidate feedback

### ET 3.2

Install, test, commission and handover heat pump systems.

| **Name:** | **Class:** | **Date:** |
|---|---|---|
| **Result:** | **Assessor:** | **Date:** |

| **Marking schedule** | **Yes** | **No** |
|---|---|---|
| (a) Plan and prepare for the installation of heat pumps (non-refrigerant systems). | | |
| (b) Install air and ground source heat pump units. | | |
| (c) Test and commission a ground source heat pump installation. | | |
| (d) Test and commission an air source heat pump installation. | | |
| (e) Handover an air or ground source heat pump installation. | | |
| Candidate feedback | | |
| Candidate's response | | |
| Candidate's signature Date | | |

**Note to assessor:** Candidate feedback should relate to the PC and knowledge statements contained in the Unit.

# Appendix 1: Practical Assessment candidate work sheets

## ET 3.4

Inspect, service and maintain heat pump system installations.

### PERFORMANCE CRITERIA

(a) Undertake the non-refrigerant circuit routine service and maintenance of an air source heat pump system installation.
(b) Undertake the routine service and maintenance of a ground source heat pump system installation.
(c) Undertake fault diagnosis work on an air or ground source heat pump system installation.
(d) Undertake fault rectification work on an air or ground source heat pump system installation.

The candidate will require to make final connections to an air source heat pump in accordance with the PC and knowledge statements above.

The candidate will work on one air source and one ground source heat pump installation. Each system shall have a fault in the non refrigerant circuit. The candidate is required to diagnose and repair the faults.

All in accordance with the Performance Criteria (a)–(d) above and the range statement contained in the Unit.

## Marking schedule and candidate feedback

### ET 3.4

Inspect, service and maintain heat pump system installations.

| **Name:** | | **Class:** | **Date:** |
|---|---|---|---|
| **Result:** | **Assessor:** | | **Date:** |

| **Marking schedule** | **Yes** | **No** |
|---|---|---|
| (a) Undertake the non-refrigerant circuit routine service and maintenance of an air source heat pump system installation. | | |
| (b) Undertake the routine service and maintenance of a ground source heat pump system installation. | | |
| (c) Undertake fault diagnosis work on an air or ground source heat pump system installation. | | |
| (d) Undertake fault rectification work on an air or ground source heat pump system installation. | | |
| Candidate feedback | | |
| Candidate's response | | |
| Candidate's signature Date | | |

**Note to assessor:** Candidate feedback should relate to the PC and knowledge statements contained in the Unit.

# Appendix 1: Practical Assessment candidate work sheets

## ET 4.2

Install, commission and handover rainwater harvesting and grey water reuse systems.

### PERFORMANCE CRITERIA

(a) The candidate will plan and prepare for the installation of rainwater harvesting and grey water reuse systems.
(b) Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition.
(c) Install rainwater harvesting and grey water reuse system components.
(d) Test and commission rainwater harvesting and grey water reuse systems.
(e) Handover rainwater harvesting and grey water reuse systems.

The candidate will require to make the final water distribution connections to a rainwater harvesting and a grey water reuse system.

All in accordance with the Performance Criteria (a)–(e) above and the range statement contained in the Unit.

# Marking schedule and candidate feedback

## ET 4.2

Install, commission and handover rainwater harvesting and grey water reuse systems.

| **Name:** | **Class:** | **Date:** |
|---|---|---|
| **Result:** | **Assessor:** | **Date:** |

| **Marking schedule** | **Yes** | **No** |
|---|---|---|
| (a) The candidate will plan and prepare for the installation of rainwater harvesting and grey water reuse systems. | | |
| (b) Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition. | | |
| (c) Install rainwater harvesting and grey water reuse system components. | | |
| (d) Test and commission rainwater harvesting and grey water reuse systems. | | |
| (e) Handover rainwater harvesting and grey water reuse systems. | | |
| Candidate feedback | | |
| Candidate's response | | |
| Candidate's signature Date | | |

**Note to assessor:** Candidate feedback should relate to the marking schedule.

# Appendix 1: Practical Assessment candidate work sheets

## ET 4.4

Inspect, service and maintain rainwater harvesting and grey water re use systems.

**PERFORMANCE CRITERIA**

(a) Undertake the routine service and maintenance of rainwater harvesting and grey water reuse systems. Obtain the relevant information required to enable the work.
(b) Undertake fault diagnosis work on rainwater harvesting and grey water reuse systems installations.
(c) Undertake fault rectification work on rainwater harvesting and grey water reuse systems installations.
(d) Undertake post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition.

- poor or no flow into storage tank
- system pump fails to operate
- back-up water supply fails to operate
- water quality is unacceptable
- undue system noise or vibration

The candidate should diagnose and repair four faults from the above list on either a rainwater harvesting or grey water reuse system.

All in accordance with the Performance Criteria (a)–(e) above and the range statement contained in the Unit.

## Marking schedule and candidate feedback

ET 4.4

Inspect, service and maintain rainwater harvesting and grey water reuse systems.

| **Name:** | | **Class:** | **Date:** |
|---|---|---|---|
| **Result:** | **Assessor:** | | **Date:** |

| **Marking schedule** | | **Yes** | **No** |
|---|---|---|---|
| (a) | Undertake the routine service and maintenance of rainwater harvesting and grey water reuse systems. Obtain the relevant information required to enable the work. | | |
| (b) | Undertake fault diagnosis work on rainwater harvesting and grey water reuse systems installation. | | |
| (c) | Undertake fault rectification work on rainwater harvesting and grey water reuse systems installations. | | |
| (d) | Undertake post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition. | | |
| Candidate feedback | | | |
| Candidate's response | | | |
| Candidate's signature | Date | | |

**Note to assessor:** Candidate feedback should relate to the marking schedule.

# Appendix 2: Model Answers

The centre will require to develop their own model answers as these will depend on the equipment types used.

Model answers should be developed by the assessor prior to assessing candidates.

# Exemplar Assessment Emergent Technologies

**NOTE: All exemplars should be replaced with the actual systems you have installed**.

## Exemplar Assessment

## Solar Thermal

### ET 2.2

Install, test, commission and handover solar thermal hot water system.

The candidate is required to install, test commission and handover a solar thermal hot water system.

*The system comprises a Solar thermal Collector, connected to a dual coil cylinder, with secondary heating provided by a gas boiler. A 3 $m^2$ flat plate collector connected to a dual coil cylinder of 170l capacity is used.*

*The collector is fixed to a south facing roof with a 40$^o$ pitch.*

The candidate is required to:

(a) Plan and prepare for the installation of 'active' solar thermal hot water system.
(b) Install key solar thermal hot water system components.
(c) Test and commission an 'active' solar thermal hot water system.
(d) Handover an 'active' solar thermal hot water system.

**Exemplar answer**

(**Note:** Red text could be deleted and the forms used for the assessment).

**ET 2.2 (A)**

Undertake pre-installation checks for a solar hot water system installation.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to check that the installation you are about to work on complies with current regulations and manufacturer's instructions you should record your actions below.

I checked the existing hot water system.

I checked availability of suitable electric connection.

I checked the installation for compliance with, the manufacturer's instructions,

I checked tables to ensure that the collector size was adequate for the storage capacity of the cylinder.

I checked charts to ensure the roof angle would allow optimum performance of the solar collector.

I checked charts to ensure that the roof orientation would allow optimum performance of the solar collector.

**2.2 (B)**

Install key solar thermal hot water system components.

| Name: | Class: | Date: |
|---|---|---|

You are required to make final connections to the solar collector.

## Model Answer risk assessment

| Identify Hazard | Dangers/Harm | Risk L/M/H | Control measures | Risks L/M/H |
|---|---|---|---|---|
| **Access** | Falls | High | Competent person, Training, Scaffold | Low |
| **Work on system** | Burns/scalds | High | Competent person, Training, cover collector to insulate from Sun while working, PPE | Low |
| **Hand Tools** | Cuts<br>Bruises | Med | Competent Person, Training, Correct use of tools, PPE | Low |
| **Electric Shock** | Death/burns | High | Competent Person, Training, Use safe isolation procedure, locks | Low |
| **Environment** | Pollution | Med | Competent Person, Training, use correct disposal methods for unwanted materials/fluids | Low |

**2.2 (B)** Install key solar thermal hot water system components and

**2.2 (C)** Prepare a fully-filled or drainback solar thermal hot water system for testing and commissioning.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to make final connections to the solar collector, inspect the completed system fill, test and commission the completed system. You should record your actions below.

Fully filled system. I flushed the system with cleanser, filled it with water and tested it to 2bar. Drained the system and refilled with the correct water anti freeze inhibitor mixture.
Vented the pump, set the controller to the override, ran pump continuously for 5 minutes to clear any air from the system. Checked system pressure in accordance with manufacturer's instructions. Adjusted the pump to give a flow rate of 3l per minute. Re checked all joints for leaks, disconnected the filling loop. Check the route of the pressure relief valve. Isolate automatic air vent.

I set the differential pressure controller to 4–8$^{o}$C and tested the operation of the unit by placing the sensor in a container of freezing water and then placing it in a container of near boiling water. It worked correctly.
Finally I set the unit to Auto mode.

Handover

I explained the operation of the system and components to the client. I completed manufacturer's forms. I handed all installation instructions over to the client and explained that they should keep them in a safe place for the use of any person who comes to maintain the system.

## ET 2.4

Inspect, service and maintain solar thermal hot water systems.

The candidate is required to:

(a) Undertake the routine service and maintenance of an ‘active’ solar thermal hot water system.
(b) Undertake fault diagnosis work on ‘active’ solar thermal hot water system installations.
(c) Undertake fault rectification work on ‘active’ solar thermal hot water system Installations.

## ET 2.4 (a)

Obtain the relevant information required to enable the work.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to undertake a visual service and maintenance inspection of a fully filled active solar thermal hot water system installation. You should record your actions below.

I obtained the manufacturer’s installation instructions for all components used in the system
I checked the installation for compliance with statutory regulations.
I inspected the system including position, condition, cleanliness and security of fixings.

I checked the pressure in the system, sampled the system fluid for antifreeze and conditioner content, operation of the pressure relief valve, pre charge of expansion vessel.

I checked the operation of the system controls and adjusted where necessary.

I completed the service record and handed it over to the client.

**ET 2.4 (b)**

Obtain the relevant information required to enable the fault diagnosis work.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to diagnose the cause of a minimum of **four** separate faults.

Complete your answers below.

Any **four** from list

Loss of system pressure without evidence of discharge.
Leak in system

Discharge from pressure relief valve on the solar primary circuit.
Failure of expansion vessel.

Insulation melting on solar collector circuit pipework.
Incorrect grade of insulation used.

Overheating of solar collector circuit.
Insufficient hot water storage.

Lack of circulation within the solar collector circuit.
The pump has failed.

Poor or no system performance
Solar collector placed in a shaded area

System noise and/or vibration.
Pipe and/or components not correctly fixed.

## ET 2.4 (c)

Obtain the relevant information required to enable the fault diagnosis work.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to obtain the relevant information required to enable the fault rectification work.

Take relevant precautionary actions to prevent unauthorised use of the system prior to or during the fault rectification work.

Take relevant precautionary actions to minimise the risk of injury to self or others during the fault rectification work.

Rectify a minimum of **two** separate faults from the following list:

You should record you actions below.

Loss of system pressure without evidence of discharge.
I repaired a leak in the pipework

Discharge from pressure relief valve on the solar primary circuit.
I replaced the expansion vessel

Insulation melting on solar collector circuit pipework.
I replaced the defective insulation with insulation of the correct grade.

Overheating of solar collector circuit.
I added a buffer vessel to the circuit.

Lack of circulation within the solar collector circuit.
I replaced the pump

Poor or no system performance.
I Moved the solar collector to a correctly orientated part of the roof.

System noise and/or vibration.
I secured loose pipework and components

# Exemplar assessment

# Ground and Air Source Heat Pumps

| Name: | Class: | Date: |
|---|---|---|

## ET 3.2

Install, test, commission and handover heat pump systems.

### PERFORMANCE CRITERIA

(a) Plan and prepare for the installation of heat pumps (non-refrigerant systems)
(b) Install air and ground source heat pump units
(c) Test and commission a ground source heat pump installation
(d) Test and commission an air source heat pump installation
(e) Handover an air or ground source heat pump installation

**ET 3.2 (a)**

Plan and prepare for the installation of heat pumps (non-refrigerant systems).

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to plan and prepare for the installation of ground and air source heat pumps. You should record you actions below. The ground source heat pump is a 10 kw horizontal aray. There is 360 $m^2$of ground available for the array. Both types of heat pump are being connected to underfloor heating. (assessors, note you should change this statement to the installation you are using).

You should record your actions below.

I checked the following, which were all satisfactory.

There is authorisation for the work to proceed
There is available and appropriate access to all work areas
All relevant information for the installation is available
The position of the fan coil unit for an air source heat pump is correct
There is 360$m^2$ of ground available for the collector which is adequate
Heat loss calculations provided indicate a requirement of 9kw so the heat pump is correctly sized
The proposed heat pump location is suitable
The underfloor heating system is compatible with both types of heat pump
There is a suitable electrical connection for the heat pump
All key system components are sited correctly
The installation does not affect the integrity of the building structure

**ET 3.2 (b)**

Install air and ground source heat pump units.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to install in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures an air source heat pump to include as a minimum the final connection of the heat pump unit to the hydraulic emitter circuit.

You should record your actions below.

I completed final connections from the air source heat pump to the underfloor heating circuit.
I completed final connections from the ground source heating pump to the underfloor heating circuit.

**ET 3.2 (c&e)**

Test and commission a ground source heat pump installation.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to test and commission and handover a ground source heat pump system. You should record you actions below.

I inspected the installation to ensure that it complied with the design/specification, manufacturer(s) requirements, statutory regulations, industry procedures and the client's requirements, I also checked that there was a suitable electrical supply.

I isolated the array circuit from the heat pump.
I connected a suitable pump to the array circuit and flushed it to remove any debris.

I then filled the array circuit with water and pressure tested it, added water and antifreeze, purged for micro air bubbles. A quantity of biocide as recommended by the manufacturer was introduced to the array

I then did several tests with a refractometer to ensure that the anti freeze would protect the system down to -15$^{o}$C

After purging the heat pump, I connected it to the ground array and purged the entire system until all air bubbles were removed.

I then tested and set all controls

I completed the manufacturer's commissioning certificate

I gave the installation a final visual check prior to handing over to the client.

I gave the client all relevant installation instructions and system drawings, explained and demonstrated the operation of the system to them.

## ET 3.2 (d&e)

Test and commission an air source heat pump installation.

| Name: | Class: | Date: |
|---|---|---|

You are required to test and commission and handover an air source heat pump system.

You should record your actions below.

I inspected the installation to ensure that it complied with the design/specification, manufacturer(s) requirements, statutory regulations, industry procedures and the client's requirements.

I connected a suitable pump to the system and flushed through to remove debris.
I then pressure tested the system following which corrosion inhibitor and anti freeze was added.

I then tested the operation of all controls, Set up the controls to operate the system to the clients requirements.

I completed and recorded the commissioning in accordance with the manufacturer's instructions.

I gave the client all relevant installation instructions and system drawings, explained and demonstrated the operation of the system to them.

## ET 3.4 (a)

Undertake the non-refrigerant circuit routine service and maintenance of an air source heat pump system installation.

| Name: | Class: | Date: |
|---|---|---|

You are required to undertake the non refrigerant circuit routine service and maintenance of an air source heat pump system installation.

You should record your actions below.

I obtained the manufacturer's instructions for the system also the installation diagrams.

I visually inspected the system for compliance with regulations, manufacturer's instructions, and condition, security and location of all system components and controls.

I checked fluid levels and using a spectrometer checked that the antifreeze was suitable.

I checked the system pressure levels.

I checked that all the system controls were set and operating correctly.

I completed the service record and handed it over to the client.

**ET 3.4 (b)**

Undertake the non-refrigerant circuit routine service and maintenance of a ground source heat pump system installation.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to undertake the non refrigerant circuit routine service and maintenance of a ground source heat pump system installation.

You should record your actions below.

I obtained the manufacturer's instructions for the system also the installation diagrams.

I visually inspected the system for compliance with regulations, manufacturer's instructions, condition, security and location of all system components and controls.

I checked fluid levels and using a spectrometer checked that the antifreeze was suitable.

I checked the system pressure levels.

I checked that all the system controls were set and operating correctly.

I completed the service record and handed it over to the client.

## ET 3.4 (c)

Undertake fault diagnosis work on an air or ground source heat pump system.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to diagnose a minimum of **four** separate faults from the list below.

You should record your actions below.

(**Note to assessor:** Faults should be set up on working systems from the list in (c))

Heat pump low pressure trip/alarm has been activated.
Obstruction in air supply to air source heat pump.

Heat pump high pressure trip/alarm has been activated.
Valve closed in heating circuit.

Poor or no collector circuit performance.
Pump in collector circuit jammed.

Insufficient heat output to emitter circuit.
Heat pump to small.

Domestic hot water heat up is satisfactory but space heating is not operating.
Faulty control valve.

System noise or vibration.
Loose pipework.

## ET 3.4 (d)

Undertake fault rectification work on an air or ground source heat pump.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

Obtain the relevant information required to enable the fault rectification work.

Take relevant precautionary actions to prevent unauthorised use of the system prior to or during the fault rectification work.

Take relevant precautionary actions to minimise the risk of injury to self or others during the fault rectification work.

You are required to rectify a minimum of **two** separate faults.

You should record your actions below.

Heat pump low pressure trip/alarm activated by a collector circuit malfunction.
I Cleared obstruction from air vents in heat pump.

Heat pump high pressure trip/alarm activated by an emitter circuit malfunction.
I Opened valve in heating circuit.

Poor or no collector circuit performance.
Clean pump in collector circuit.

Insufficient heat output to emitter circuit.
Either fit supplementary heating or replace heat pump with one of suitable size.

Domestic hot water heat up is satisfactory but space heating is not operating.
I Opened a valve.

System noise and/or vibration.
I secured loose pipework.

# Exemplar assessment

# Install, Test, Commission and handover Rainwater Harvesting/Grey water Reuse Systems. Inspect Service and Maintain Rainwater Harvesting/Grey water Reuse Systems

## ET 4.2

Install, commission and handover rainwater harvesting/grey water reuse systems.

### PERFORMANCE CRITERIA

(a) The candidate will plan and prepare for the installation of rainwater harvesting/grey water reuse systems.
(b) Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition.
(c) Install rainwater harvesting and grey water reuse system components.
(d) Test and commission rainwater harvesting and grey water reuse systems.
(e) Handover rainwater harvesting and grey water reuse systems.

## 4.2 (a)

Undertake pre-installation checks for a rainwater harvesting/grey water reuse system.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

(a) Undertake pre-installation checks for a rainwater harvesting system installation.

You are required to inspect the rainwater harvesting system that you are about to make final connections on. It is supplying a house in the west of Scotland with four occupants, 4l WC cistern and a 200 $m^2$ Garden. The available collection area is 50 $m^2$ and a 34 $m^3$ storage tank.

You should record your actions below.

The suitability of the proposed installation in relation to:

- yield
- usage
- any special features.

I calculated that the area will yield sufficient water for the demand. There were no special features.

The suitability of the building structure and the building fabric in relation to the installation of system components.

I inspected the installation the structure was suitable.

The inspection of the existing water supply installation.

The installation was all correct with suitable back flow protection.

The inspection of the existing rainwater installation.

The existing rainwater installation was all correct with suitable identification labels/tape and backflow protection

The availability of a suitable electrical input service.

There is a suitable electrical supply

The proposed siting of key internal system components

The siting of key components is correct.

## 4.2 (b)

Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition.

| Name: | Class: | Date: |
|---|---|---|

You are required to check the tools, materials and equipment supplied for the installation are available and are in safe and usable condition.

You should record your actions below.

Confirm that the tools materials and equipment required for the installation work are available and are in safe and usable condition.
I checked that the tools were in a safe and usable condition.

I checked that all materials for the installation were available and in usable condition

## 4.2 (c)

Install rainwater harvesting/grey water reuse system components.

| Name: | Class: | Date: |
|---|---|---|

You are required to install in accordance with manufacturer's guidance, regulatory requirements and industry required procedures, key system components on either a rainwater harvesting or grey water reuse system to include as a minimum the positioning, fixing and connection of the following components:

- storage tank (connection to tank only)
- system control unit (water connections only)
- Pump

You should record your actions below.

Rainwater harvesting

storage tank (connection to tank only)

I made the final connection of the surface water to the storage tank.

system control unit (water connections only)

I made the final water connections to the control unit.

Pump

I made the final distribution pipe connection to the pump and lowered it into position in the storage tank.

**4.2 (d)**

Test and commission rainwater harvesting/grey water reuse systems.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to prepare a rainwater harvesting system for testing and commissioning.

You should record your actions below.

I inspected the installation to ensure that it complied with the design/specification, manufacturer(s) requirements, statutory regulations, industry procedures and the client's requirements.

I checked the electrical supply

I flushed the system to remove all debris

I filled the storage tank

I checked that the correct marking and labelling was attached to system pipework and components.

Testing

I connected a pump and pressure tested the stored water distribution pipe.

I tested the operation of the rainwater inlet filter and overflow pipe.

I then tested the operation of all controls, Set up the controls to operate the system to the clients requirements.

**4.2 (e)**

Handover rainwater harvesting/grey water reuse system.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

You are required to carry out the relevant checks on a rainwater harvesting system to ensure that the system is ready for handover and compliant with manufacturer's guidance, the system design/specification, clients requirement's, regulatory requirements and/or industry recognised requirements.

You should record your actions below.

I checked the rainwater harvesting system it was working correctly, there were no cross connections between the rainwater distribution and the cold water service pipe.

I checked that all controls were set up to operate the system correctly.

I completed and recorded the commissioning in accordance with the manufacturer's instructions.

I explained the operation of the system to the client.

I handed over completed commissioning certificate, manufacturer's installation instructions and system drawings to the client.

## ET 4.4

Inspect, service and maintain rainwater harvesting/grey water reuse systems.

**PERFORMANCE CRITERIA**

(a) Undertake the routine service and maintenance of rainwater harvesting and grey water reuse systems. Obtain the relevant information required to enable the work.
(b) Undertake fault diagnosis work on rainwater harvesting and grey water reuse systems installations.
(c) Undertake fault rectification work on rainwater harvesting and grey water reuse systems installations.
(d) Undertake post-rectification functional tests in accordance with manufacturer's guidance, regulatory requirements and industry recognised procedures to confirm that the system is in a safe, functional and efficient condition.

## 4.4 (a)

Undertake the routine service and maintenance of rainwater harvesting/grey water reuse systems. Obtain the relevant information required to enable the work.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

(a) You are required to undertake the routine service and maintenance of a rainwater harvesting/grey water reuse system. Obtain the relevant information required to enable the work.

You should record your actions below.

I obtained manufacturer's instructions for all components of the system

I obtained installation diagrams for the system

I checked the condition of the roof and gutters

I checked and cleaned the inlet filter.

I visually checked that the water in the storage tank was clear.

I checked that there was no debris in the tank

I smelled the tank to ensure that no smells were being admitted from the drains

I checked the condition of all electrical connections

I checked the operation of mains back up

I checked the seal in the trapped connection to the overflow

I checked the operation of the pump and floating filter

I cleaned the floating filter

I checked that the flow of rainwater was not obstructed by air

I checked that water level gauge was indicating correctly

I checked the condition of the electrical wiring

I checked that all pipework was watertight and adequately protected

I checked that all pipework and outlets were marked as carrying non potable water and not fit for drinking

I completed the service record and gave it to the client

## 4.4 (a)

Undertake the routine service and maintenance of rainwater harvesting/grey water reuse systems. Obtain the relevant information required to enable the work.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

(a) You are required to undertake the routine service and maintenance of an Ecoplay grey water reuse system. Obtain the relevant information required to enable the work.

You should record your actions below.

I obtained manufacturer's instructions for all components of the system.

I obtained installation diagrams for the system.

I checked that the bath waste was connected correctly

I checked to see if the tank was clean.

I purged the tank to clean it.

I checked the operation of mains water back up.

I checked that the electrical wiring was in good condition.

I completed the service record and gave it to the client.

**4.4 (b)**

Undertake fault diagnosis work on a rainwater harvesting/grey water reuse system.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

Undertake fault diagnosis work on rainwater harvesting/grey water reuse system.

Obtain the relevant information required to enable the fault diagnosis work.

Diagnose the cause of a minimum of **four** separate faults on a rainwater harvesting/greywater reuse system from the following list:

You should record your actions below.

I obtained manufacturer's installation and maintenance instructions.

Poor or no flow into storage tank

Debris choking the inlet filter.

System pump fails to operate.

Fault in the control panel.

Back-up water supply fails to operate

Fault in flow switch.

Water quality is unacceptable.

Inlet filter damaged/ not properly in place.

Undue system noise or vibration.

Pipework not secured properly.

**4.4 (b)**

Undertake fault diagnosis work on a harvesting/grey water reuse system.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

Undertake fault diagnosis work on an Ecoplay, grey water reuse system.

Obtain the relevant information required to enable the fault diagnosis work.

Diagnose the cause of a minimum of **four** separate faults on a rainwater harvesting and/or grey water from the following list:

You should record your actions below.

I obtained manufacturer's installation and maintenance instructions.

Poor or no flow into storage tank

Drain from shower or bath choked.

System pump fails to operate.

Not applicable

Back-up water supply fails to operate

Fault in flow switch.

Water quality is unacceptable.

Build up of scum in the tank

Undue system noise or vibration.

Pipework not secured properly.

Consulted client on fault rectification procedures.

**Page 90 and 91 could be combined**

## 4.4 (c)

Undertake fault rectification work on a rainwater harvesting/grey water resuse system.

| Name: | Class: | Date: |
|---|---|---|

Undertake fault rectification work on a rainwater harvesting system installation.

Rectify **two** separate faults on a grey water recycling system from the following list.

You should record your actions below.

I obtained manufacturer's installation and maintenance instructions.

Poor or no flow into storage tank

I cleaned the inlet filter.

System pump fails to operate.

I repaired a fault in the control panel.

Back-up water supply fails to operate

I replaced faulty flow switch.

Water quality is unacceptable.

I replaced inlet filter.

Undue system noise or vibration.

Pipework not secured properly.

**4.4 (c)**

Undertake fault rectification work on a grey water recycling system.

| **Name:** | **Class:** | **Date:** |
|---|---|---|

Undertake fault rectification work on a grey water recycling system installation.

Rectify **two** separate faults on an Ecoplay grey water recycling system from the following list.

You should record your actions below.

I obtained manufacturer's installation and maintenance instructions.

Poor or no flow into storage tank

I cleared choke from bath waste

System pump fails to operate.

Not applicable

Back-up water supply fails to operate

I replaced faulty flow switch.

Water quality is unacceptable.

I purged the tank.

Undue system noise or vibration.

I secured loose pipework.