T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Building Services Engineering for Construction

Refrigeration Engineering

Guide standard exemplification material

Distinction – Sample 2021

City & Guilds | eal

Contents

Introduction

The sample assessment materials within this document refers to the refrigeration engineering sample occupational specialism assignment. The aim of these materials is to provide centres with examples of knowledge, skills and understanding that attest to a distinction grade. In this document all exemplar evidence attests as examples of a distinction grade. The examples provided do not reflect all evidence from the sample assignment as the focus of this material is the quality and standards that need to be achieved rather than the volume of exemplar evidence provided. However, the examples provide a representative of all tasks in the sample assignment. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and standard of performance will vary across tasks. A distinction grade will be based on a synoptic mark across all tasks.

The materials in this GSEM are separated into three sections as described below. Materials are presented against a number of tasks from the assignment.

Task

This section details the tasks that the candidate has been asked to carry out. What needs to be submitted for marking and any additional evidence required including any photographic evidence. Also referenced in this section are the assessment themes the candidates will be marked against when completing the tasks within it. In addition, candidate evidence that has been included or not been included in this GSEM has been identified within this section.

In this GSEM there is candidate evidence from:

Task 1
Task 2
Task 3
Task 4

Candidate evidence

This section includes exemplars of candidates work, photographs of the work in production (or completed) and practical observation records of the assessment completed by centre assessors. This will be actual evidence that was captured as part of the assessment and then internally marked by the centre assessor.

Commentary

This section includes detailed comments to demonstrate how the candidate evidence attests to the standard of distinction by directly correlating to the grade descriptors for this occupational area. Centres can compare the evidence against the performance indicators in the marking grid descriptors within the assessor packs, to provide guidance on the standard of knowledge, skills and understanding that need to be met for a distinction grade

It is important to note that the commentary section is not part of the evidence or assessment but are evaluative statements on how and why that piece of evidence meets a particular standard.

Grade descriptors

To achieve a Distinction, a candidate will be able to:

Demonstrate an exemplary performance that fully meets the requirement of the brief and is able to enter the industry to begin to work in the occupational area.

Demonstrate exemplary technical skills in cutting, bending, fixing pipework and installing components that is in line with industry standards.

Demonstrate relevant and comprehensive knowledge and understanding of refrigeration principles and processes through the tasks completed.

Work safely showing an understanding in the selection and use of tools and equipment and demonstrate an advanced awareness of straightforward preparation and application processes.

Stay solution focussed, confidently attempting to diagnose complex tasks and faults in refrigeration. They will be able to accurately research, identify and rectify issues and independently.

Consistently uses industry terminology that is accurate in both written and verbal contexts.

Task 1 – Design

(Assessment themes: health and safety, design, and planning)

For task 1 candidates need to produce the following pieces of evidence:

- Completed calculation showing all workings

Candidate evidence not included within this GSEM:
N/A

Candidate evidence

Completed calculation showing all workings.

HEAT LOADS WALLS ETC. (DIST)

WALLS $17 \times 3.2 \times .19 \times 52 = 537.472$ W

FLOOR $5 \times 3.5 \times .25 \times 35 = 153.125$ W

ROOF $5 \times 3.5 \times .15 \times 52 = 136.500$ W

TOTAL HEAT LOAD = 827.097 W

PRODUCT LOAD

ABOVE F° $Q = mC\Delta T = 500 \times 3.2 \times (5 - -2) = 11200$ KJ

LAT HT $Q = mL = 500 \times 230 = 115000$ KJ

BELOW F° $Q = mC\Delta T = 500 \times 1.7 \times (-2 - -20) = 15300$ KJ

TOTAL = 141500 KJ

HEAT LOAD $= \frac{141500}{8 \times 3600} = 4.91$ KW

OTHER LOADS

DEFROST HEATER: $5000 \times \frac{1}{24} = 208.33$ W

FLOOR HEATE: $5 \times 35 \times 15 = 262.5$ W

LIGHTING: $300 \times \frac{8}{24} = 100$ W.

DOOR HEATER: = 50 W

FAN MOTOR: $3 \times 550 \times \frac{23}{24} = 1581.25$ W.

OCCUPATION: $230 \times 2 \times \frac{4}{24} = 76.66$ W

TOTAL = 2278.74 W

TOTAL LOAD = .82709 + 4.91 + 2.27874 = 8.015 KW

Commentary

The candidate has completed the calculation accurately and demonstrated detailed working out including to three decimal places with only rounding the final answer demonstrating a good understanding of mathematical principles. This ensures the most accurate design calculations are considered as part of the planning process to give an estimated heat load for the entire cold room.

Candidate has demonstrated an excellent level of understanding for heat gains to a cold room and how this can impact on design and installation of refrigeration systems. The candidate has considered all the possible heat gains and correction factors in calculating the total heat gain to a room and made the correct use of the data provided to make the calculation.

Task 2 – Planning the installation

(Assessment themes: Design and planning, systems and components)

For task 2 candidates need to produce the following pieces of evidence:

- Risk assessment
- Method statement with justifications
- Installation drawing showing all location dimensions of indoor and outdoor units and pipe route
- Materials list
- Measurements and marking out of space allocation/ work area checked against the installation drawing

For illustration, the guided exemplification materials (GSEM) for Task 2 contain examples of candidate evidence for the following assessment requirements only:

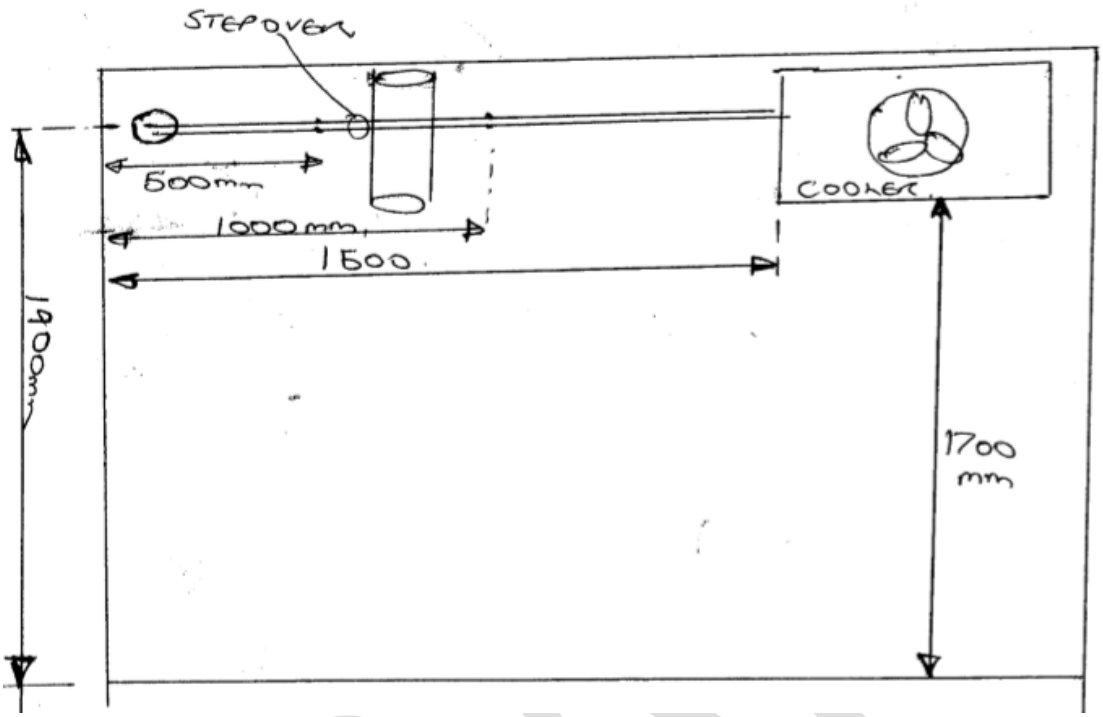
- Risk assessment
- Method statement with justifications
- Installation drawing showing all location dimensions of indoor and outdoor units and pipe route
- Materials list

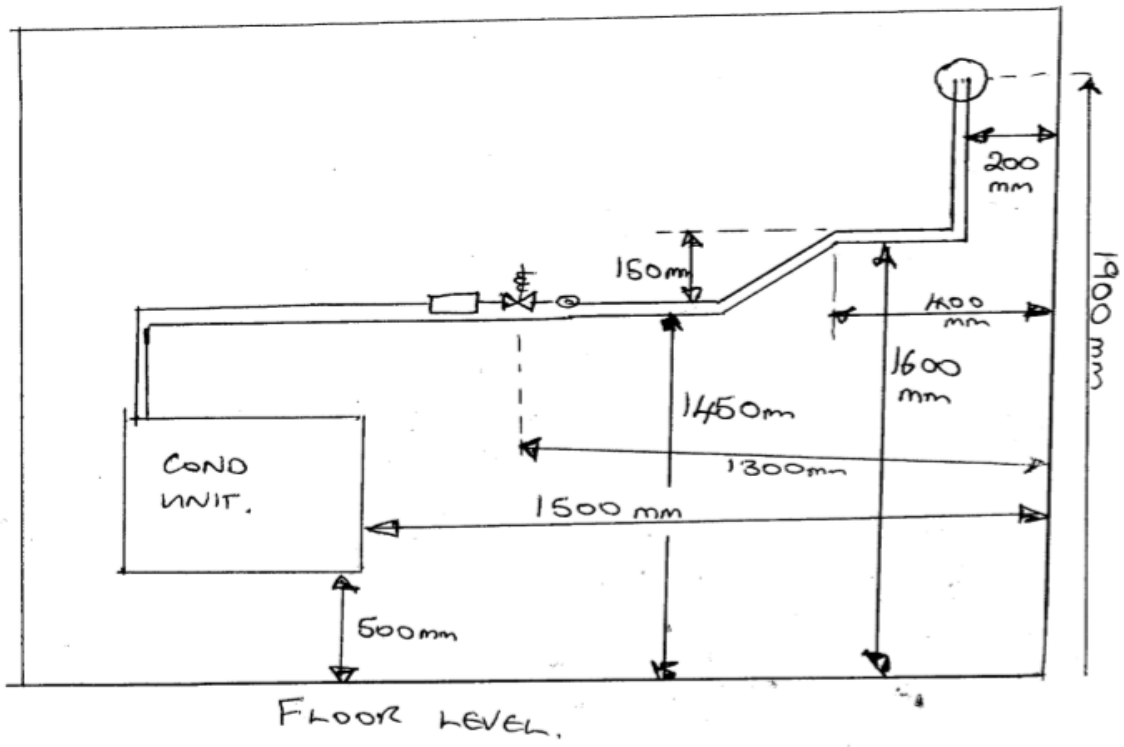
The following task 2 candidate assessment requirements have not been included as example candidate evidence for this version of the guided exemplification materials.

- Assessor observation of measurements and marking out of space allocation/ work area checked against the installation drawing

Candidate evidence

Installation drawing





Commentary

The candidate has demonstrated excellent knowledge and understanding through the completion of the drawing considering all the aspects of the design brief. The drawing of the installation is annotated to include all pipe sizes and dimensions contained within the brief and is appropriate to industry standards.

The candidate has completed the drawing considering all the aspects of the design brief. They have correctly identified all the components and produced a detailed drawing. The completed drawing is well presented and accurate with all dimensions included.

Candidate evidence

Risk assessment

This risk assessment may be modified by adding items only

Activity: Cold room installation **Location: Office workshop**	**Date: 23/02/21** **Position: Candidate**

SEVERITY (S): Degree of harm which may be caused (including numbers affected) **1 Minor Injury 2 Major Injury 3 Fatality** **LIKELIHOOD (L): Probability that event will occur** **1 Remote 2 Possible 3 Likely**	**RISK RATING (RR): Severity x Likelihood** **1-3 Low** **4-6 Medium** **7-9 High**

Item No:	Activity:	Hazard	Persons at Risk	Existing Controls (Mitigation)	S 1-3	L 1-3	RR	Are the Risks Controlled?
1	Pipe installation	Slip, Trips, Falls	Operator	Keep work area clean and tidy. Be mindful of other workers around work area	1	1	1	Yes
		Fall from height	Operator, other in work area	Check ladder, maintain 3 points of contact, barrier off work area, get someone to foot ladder before use and tie off top and bottom	2	1	2	Yes
		Cuts and grazes	Operator		1	1	1	Yes

				Wear protective gloves and goggles when cutting and deburring pipe				
2	Brazing, jointing pipework	Burns, Fire, Explosion	Operator, others in work area	Wear protective gloves and goggles at all times when brazing. Cool down hot joints or put-up warning signs. Remove or protect any flammable materials or surfaces. Have fire extinguisher next to brazing area. Fire watch for 1 hour after brazing Check brazing equipment before use, Leak check equipment and hoses and operation and setting of regulators	1	2	2	Yes
3	Manual handling	Muscle strain, crush injury	Operator, others in work area	Maximum single person lifts 25kg. Two man lift if over 25kg. Use mechanical lifting aids if at all possible	1	1	1	Yes
4	Pressure testing	Explosion Asphyxiation	Operator, others in work area	Check operation and setting of equipment before use. Clear area, barrier off and put-up warning signs. Work in well ventilated area only, check with tutor if working in a confined space.	1 1	2 1	2 1	Yes

5	Electrical work	Electric shock	Operator, others in work area	Isolate and lock off mains supply before work. Test supply is dead. Live and functional testing must be supervised at all times.	1	2	2	Yes
6	Commissioning	Asphyxiation Explosion Cold burns Electric shock	Operator, others in work area	Work in well ventilated area. Check operation and settings of all regulators and valves before start. Wear gloves, goggles and long sleeved overall when handling refrigerant. All live and functional testing to be closely supervised.	1	1	1	Yes

Commentary

The candidate identifies all major hazards and associated risks. The candidate identifies relevant controls in comprehensive detail for all the identified risks and makes justification for the control measures that are appropriate. Probability of each of the hazards/ risks occurring has been considered for all risks.

Candidate evidence

Method statement

Ensure you have the correct PPE which includes steel toe cap boots, boiler suit and heat proof hi visibility vest to ensure risk of personal injury is limited and in line with risk assessment.

I will then carry out a visual inspection to make sure my workspace is safe; I will move anything that is unwanted out of the way. I will also put a dust sheet down in my working area to keep it protected and tidy.

Indicate the component and pipework layout in pencil on the work surface to the correct measurements in line with drawing and ensuring the use of a datum line and spirit level to ensure all components and pipe-runs will be accurate. Fit the components to the correct height in line with the specification and the installation drawing.

Collect all pipework, fittings and necessary tools required to complete the installation in line with my materials list, also checking that all the fittings and materials are British standard kite marked. This is an imprint on each fitting and show that they are of the right quality for purpose. I will put them in a safe place in the working area where they are easily accessible but do not cause a trip hazard.

Measure from the centre line for the evaporator and the condensing unit brackets and drill and fix the brackets using heavy duty block work fixings according to the specification. Install all the appropriate pipe clips at equal distancing to both provide support and ensure the installation is aesthetically pleasing. Carefully and accurately measure the pipe lengths and make allowance for any X dimensions to allow for pipe gain. Cut the copper pipe, then continue to pull any angles, kicks, or passovers needed for the task.

Once all pipework is prefabricated install the pipework and add the fittings (solenoid valve, drier and sight glass) tightening any flare joints to provide some stability. When happy with the fit of the installation pipework, dismantle all joints and clean all the surfaces that are to be brazed, this will allow the brazing alloy to run smoothly once heat is applied and ensure that the installation is free from leaks. Braze all the copper joints ensuring all surfaces are protected from damage using a suitable heat mat or shield.
Using the clips already installed place the drainpipe-work into position and tighten all the mechanical joints to ensure the drain is all connected and free from leaks.

Calculate the strength (1.43 x Ps) and tightness (1 x Ps) test pressure in accordance with BS EN378-2016 where Ps is saturated pressure of the refrigerant at 55oC. Before pressurising with nitrogen check the settings of the valves and regulators, clear any person in the vicinity of the installation and erect barriers and warning signs in case of explosion.
Leak test all joints using a proprietary leak spray during the tightness test ensuring gloves and goggles are worn at all times. Clean all leak fluid off after testing to prevent corrosion or damage to pipework and fittings.

If a leak is found, depressurise the system, venting the nitrogen gas outside to prevent any chance of asphyxiation, and re-pressurise after fixing the source of the leak.
Leave the system under tightness test pressure for 24 hours, measuring the pressure and temperature at the start and finish to so pressure changes can be calculated using the Gas laws.

Commentary

The candidate demonstrates a comprehensive understanding of sequencing tasks. Detailing all aspects of the install for example, marking out tasks, collecting materials and making allowance for dimensions for fittings on straight pipe runs. This clearly demonstrates excellent understanding of the system installation processes.

The process given follows a logical and methodical process for the installation, for example, dry fixing the installation for accuracy prior to brazing. The candidate has clearly considered the aesthetics of the final installation by ensuring the pipework and surfaces are cleaned.

The candidate demonstrates a depth of knowledge and understanding regulations by accurately refencing the appropriate British Standards to which the strength and tightness testing should be carried out.

The methods described are both accurate and provide reasoning as to why the actions are carried out.

Candidate Evidence

Materials list

Equipment/Materials	Quantity
1m long Spirit level	1
Tape measure	1
Large and small pipe cutters	1
5/8” and 3/8” Pipe benders	1
Philips screwdriver	1
Adjustable spanner	2
5/8” and 3/8” soft-rolled Pipe	6 metres each
5/8 and 3/8 Flare nuts	20
Abrasive cloth	1
Copper brazing rods	2
Heat proof mat	1
Oxy-Acetylene equipment	1
CO2 fire extinguisher	1
Battery drill	1
5/8” and 3/8” pipe insulation	6 metres
5/8” and 3/8” pipe clips	10
3/8” Solenoid valve	1
3/8” Filter Drier	1
3/8” Sight glass	1
Screws and washers	20
Unistrut Brackets	2 sets
Heavy duty expansion fixings	8
Indoor unit	1
Outdoor unit	1
Vibrasorb or similar mounting blocks	
Refrigerant cylinder	1
Nitrogen cylinder	1
Nitrogen regulator and manifold	1
Leak spray	1
Clean cloths	
PPE	
Overalls	
Steel toe capped boots	
Goggles	
Gloves	

Commentary

The candidate has detailed knowledge and understanding of all resources to fully meet the assignment brief requirements. This includes components and PPE with accurate quantities and types/sizes to carry out the tasks.

Consideration has been given to aesthetics of finished product by including the use of clean clothes to allow the fixing of the brassware to be carried out without evidence of tooling damage and to clean excess leak spray fluid from pipes and fittings.

Task 3 – Install and commission

(Assessment themes: Health and safety, systems and components, inspection and testing, reports and information, handover and communication)

For task 3 candidates need to produce the following pieces of evidence:

- Pressure test certificate
- Commissioning checklist
- Assessor observations:
    - Safe isolation process
    - Installation of systems and components
    - Commission and handover system

For illustration, the guided exemplification materials (GSEM) for Task 3 contain examples of candidate evidence for the following assessment requirements only:

- Pressure test certificate
- Assessor observations:
    - Safe isolation process
    - Installation of systems and components
    - Commission and handover system

The following task 3 candidate assessment requirements have not been included as example candidate evidence for this version of the guided standard exemplification materials

- Commissioning checklist
- Commissioning photographic evidence

Photographic evidence required:

Installation

- Photograph of the offset conforming to the 150mm dimension. – demonstrates that the candidate can bend pipe accurately to a tolerance. **(photograph 1)**
- Photograph showing the offset around the soil pipe obstruction – demonstrates the candidate's pipework skills forming bend around the soil pipe. The photo demonstrates how the pipework visibly varies in distance from the soil pipe. **(photograph 2)**
- Photograph of installed components where the condensing and cooling unit match the installation drawing. This photo demonstrates the candidate's ability to install components to a +/- 5mm tolerance. **(photograph 3 and 4)**
- Four to six photographs of each brazed joint – Demonstrates how well the joint if finished. This photo demonstrates some excessive solder and scorch marks on the wall surfaces. **(photograph 5,6,7,8)**
- Two photos one each side of the wall showing finished pipework (without insulation). This demonstrates the aesthetics of the completed installation. Visible signs of pipework damage that are not straight or horizontal/vertical and bends that are not properly formed. None of which stops the system operating correctly. **(photograph 3 and 4)**

Commissioning

- Evacuation and use of vacuum gauge (not in this GSEM)
- Weighing in the refrigerant charge (not in this GSEM)
- Visual inspection of system and pipework and measurement of temperature (not in this GSEM)

Candidate evidence

Practical Observation Form – Safe isolation

Assessment ID	Qualification number
8710-358	8710-38
Candidate name	Candidate number
Candidate A	12345
Centre name	Assessment theme
City & Guilds	Health and Safety, systems and components

Assessment theme	Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.
Safe isolation	Candidate was confident in describing the industry safe isolation procedure, and how they planned to proceed with the task and described a clear logical sequence giving reasons to the process that would eliminate any risk of injury. Candidate correctly selected all the equipment required, including voltage indicator, lock off kit, correct signage. The candidate correctly checked the testing equipment and confirmed operation before continuing with tests to prove supply was DEAD. The candidate could clearly articulate the purpose of each step in ensuring the electrical supply was correctly isolated. Candidate correctly identified signage and placed notices to advise the system was isolated and tested.

Assessor signature	Date
A. Assessor	26.02.21

Commentary

Candidate confidently carried out all necessary steps in the safe isolation process.

The safe isolation process was correct in method and described in detail as to reasoning of the steps and process, for example the candidate used all the correct terminology for the testing equipment and explained what each check was proving before moving to next stage.

Candidate evidence

Practical Observation Form – Installation of components

Assessment ID	Qualification number
8710-358	8710-38
Candidate name	Candidate number
Candidate A	12345
Centre name	Assessment theme
City & Guilds	Health and safety, systems and components, inspecting and testing systems and components

Task	Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.
Installation of the refrigeration system.	Full Health and safety procedures were followed throughout the installation both in accordance with the candidate's risk assessment and industry SOP and HASWA 1974. Candidate prepared the workspace with consideration to health and safety and good housekeeping, by putting dust sheets on floor, collecting all the correct equipment, and storing tools and materials in a safe location. The candidate maintained the workspace throughout and adhered to the risk assessment throughout the installation. All tools and materials not in use were stored safely and securely until needed reducing the risk of any potential accidents Candidate details any pre-existing marks or damage to the wall prior to marking out for their installation. Candidate set about the task in a highly organized manor and prefabricated lengths of pipework including bends to ensure accuracy, consistency and efficiency and minimizing wastage of materials.

Task	Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.
	Candidate prepared the workspace using accurate clipping distancing to support the installation of pipework. This was installed with 400mm spaces with attention to aesthetics and ensuring pipework is parallel and secured. Evaporator was installed at a suitable height for correct operation however when measured was not completely accurate but within 2mm of tolerance. Candidate has effectively marked out and measured pipework to suitable lengths to carry out the installation, with no wastage of materials All tolerances met throughout the installation producing a piece of work that was aesthetically pleasing

Assessor signature	Date
A. Assessor	26.02.21

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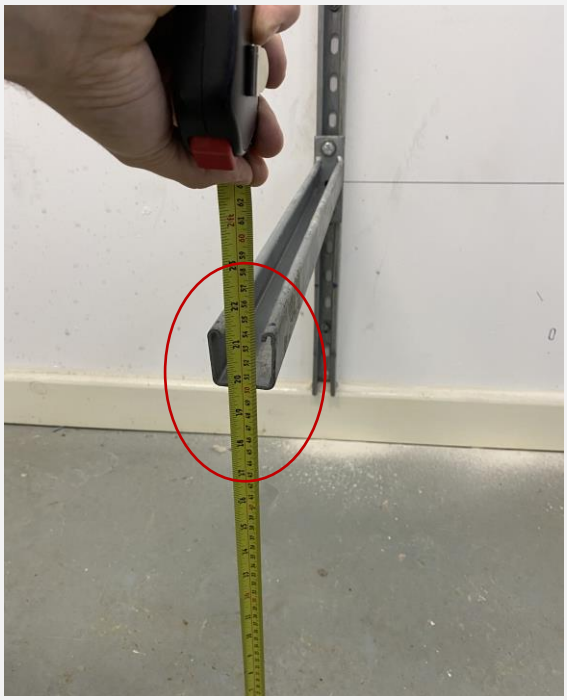
Photo:1

(Photograph 1) Demonstrates the candidate being able to work to +/- 5mm tolerance. Shows offset conforming to the 150mm dimension. – demonstrates that the candidate can bend pipe accurately to a tolerance.

Photo:2

(Photograph 2) Demonstrates the candidate's pipework skills forming bend around the soil pipe. The photo demonstrates how the pipework visibly varies in distance from the soil pipe.

Photo:3



(Photograph 3 and 4) Installed components where the condensing unit and evaporator match the installation drawing. These photos demonstrate the candidate's ability to install components to a +/- 5mm tolerance. This demonstrates the aesthetics of the completed installation.

Photo:4

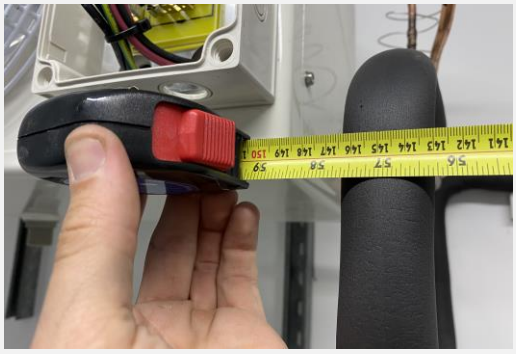


Photo:5

(Photograph 5,6,7,8)

Demonstrates how well the joint is finished. No signs of pipe damage, that the brazed joint shows good penetration, there no excess of brazing alloy and the finished braze is neat and business like.

Photo:6

Photo:7

Photo:8

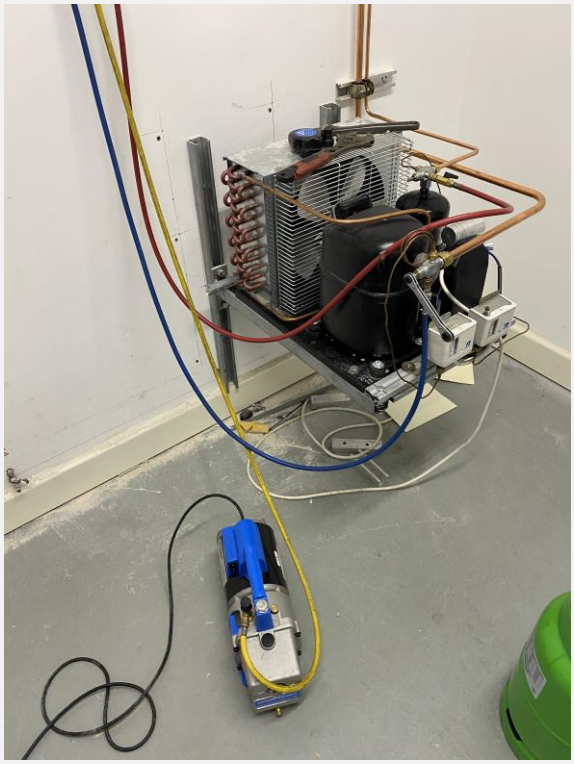
(Photograph 9 & 10)

Each side of the wall and demonstrates the overall aesthetics of the installation that pipework (no insulation installed) is free from visible damage and that pipe is installed perfectly vertical and horizontal as per the installation drawings. Bends and off sets are properly formed.

Photo:9

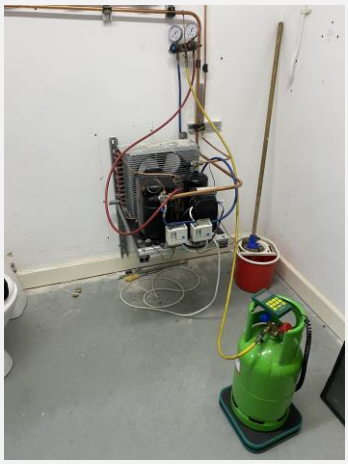
Photo:10

Photo:11



(Photograph 11) Vacuum pump and Torr gauge showing correct connections with Torr gauge at furthest point from vacuum pump

Photo:12



(Photograph 12) Correct refrigerant cylinder on scales showing gauge line connection not obstructing workspace.

Photo:13

(Photograph 13) Pipework leading up to and including the evaporator. Temperature probes and instrument correctly located.

Candidate evidence

Pressure test certificate

Evidence Recording Template - Certificate of Pressure Testing

CERTIFICATION OF PRESSURE TESTING

(IN ACCORDANCE WITH BS EN 378)

Name of client	ANY COLLEGE	Job No.	REF. ASSESSMENT
Site address	ANY STREET ANY TOWN	Date of Test.	22/2/21
Contact detail	Tel. 01234 56789	email	ACANDIDATE@COLLEGE.AC.UK
System/component under test.	REFRIG. SYSTEM.		

TEST DETAIL

Strength Test Ps x 1.43	START PRESSURE	START TEMP	DURATION	FINAL PRESSURE	FINAL TEMP	RESULT
	35	20°C	15MIN	35	20°C	OK

Tightness Test Ps x 1	START PRESSURE	START TEMP	DURATION	FINAL PRESSURE	FINAL TEMP	RESULT
	24	20°C	1 HR	24	20°C	OK

Details of person carrying out the test

Name	Signature	Date
A CANDIDATE	D Candidate	22/2/21

Details of person who witnessed the above test

Name	Status	Signature	Date
AN ASSESSOR	ASSESSOR	A Assessor	22/2/21

Commentary

Candidate follows a highly methodical and logical process for the installation of system. The candidate clearly demonstrates an ability to sequence tasks logically in particular with regard to the use of health and safety, marking and cutting materials, brazing and jointing pipework, pressure testing, charging and commissioning.

Candidate did not require reassurance and was highly focussed and assured when carrying out the installation. An example of this includes prefabricating all the pipework and accounting for dimensions to produce an installation that was accurate first time.

Candidate evidence

Practical Observation Form – Commissioning and handover to customer

Assessment ID	Qualification number
8710-351	8710-38
Candidate name	Candidate number
Candidate A	12345
Centre name	Assessment theme
City & Guilds	Handover and communication, Inspecting and testing systems and components

Assessment theme	Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.
Commissioning and hand over to customer	**Commissioning checks** Candidate follows correct process for commissioning tests using manufactures instruction for the respective condensing unit and the evaporator to ensure no aspects of the commissioning had been omitted. After completing the visual inspection, the candidate evacuated and charged the system according to the manufacturer's instructions, with refrigerant leakages kept to an absolute minimum. Before commissioning started the candidate zeroed the gauges and scales and checked the operation and calibration of all temperature sensors. The candidate measured the pressure and temperatures confidently without reference to the assessor ensuring all of the installation was commissioned to industry standards before handing over to customer. **Handover to customer** Candidate interacts well with customer keeping eye contact and an open body language. Candidate gives information about the systems and how to adjust the thermostat/controller, ensuring the customer was aware of the temperature limits of the system and its cooling capacity. The candidate provides detail of maintenance requirements e.g. cleaning processes and how to load and distribute ensuring maximum airflow. Candidate makes reference to manufactures instructions at relevant stages throughout the task.

Assessor signature	Date
Assessor A	26.02.21

Commentary

Commissioning tests are completed and follow a logical sequence. Reference is made to manufacturer's guidance at relevant stages throughout the task.

Demonstration of the system with the customer was accurate and a thorough explanation of the maintenance requirements. Customer care skills were apparent with the use of positive interaction throughout.

Task 4 – Service and maintenance

(Assessment themes: Health and safety, working with faults, systems and components, reports and information)

For task 4 candidates need to produce the following pieces of evidence:

- Maintenance report
- Pressure test certificate
- F-Gas log sheet
- Waste transfer note
- Assessor observations
  - Fault diagnosis
  - Decommissioning
  - Safe isolation
  - Fault rectification

For illustration, the guided exemplification materials (GSEM) for Task 3 contain examples of candidate evidence for the following assessment requirements only:

- Maintenance report
- Assessor observations
  - Fault diagnosis
  - Decommissioning
  - Fault rectification

The following task 4 candidate assessment requirements have not been included as example candidate evidence for this version of the guided standard exemplification materials

- Pressure test certificate
- F-Gas log sheet.
- Waste transfer note
- Assessor observation of the safe isolation process

Photographic evidence

Compressor Change (a photograph for each of the below)

- Disassembly of condensing unit demonstrating any damage, or no damage caused **(photograph 14)**
- Un-brazing and removal of compressor demonstrating damage, or no damage **(photograph 15)**
- Refitting and brazing of compressor showing damage, or no damage **(photograph 16)**
- Set up of pressure testing equipment and gauge reading **(photograph 17)**
- Leak testing to show correct safety procedures Inc. PPE and correct fluid/device. **(photograph 18)**
- Evacuation to 2 Torr – set up of equipment and gauge reading **(photograph 19)**
- Charging of system – set up of equipment **(photograph 20)**
- Final reassembly of condensing unit **(photograph 21)**

Maintenance (a photograph for each of the below)

- Clean of coils (use of spray washer) **(photograph 22)**
- Leak testing of system **(photograph 23)**
- Run and testing of temperatures and air flow **(photograph 24)**

Candidate evidence

Maintenance report

Description of fault diagnosis

Before testing the 3 compressors I check the operation of the multimeter and insulation resistance tester. I set the insulation tester to 500V as the compressors were 230V units in accordance with the 18th Edition requirements. Using the insulation resistance tester first I connected one lead to earth and the other lead to each of the three terminal pins in turn, pressing the test button while making sure I was not in contact with any of the metal work. Compressor A gave a reading of 0 Megaohms so I concluded this compressor was down to earth. Compressor B had a zero Ohms reading across the start winding and Comp C showed the correct resistance for the start and run windings and no earth fault.

Possible solutions

Because of the limited space around the compressor, I decided to cut the discharge line at a convenient place rather than un braze it at the compressor stub to avoid damaging any other components. The suction stub was more accessible, so I decided to unbraze that directly.

Actions taken to rectify fault

To repair the fault, I carried out the following sequence

Isolate the electrical supply using a lock off kit and placed warning signs.

Recover the refrigerant into a recovery cylinder.

Recover the refrigerant down to -0.3 Bar to ensure all refrigerant is removed from the system.

Unbraze the defective compressor and remove.,

Form a replacement discharge line to the new compressor before refitting so any brazing will not damage adjacent components.

Pressure and leak test all joints in accordance with BS EN378-2016

Evacuate the system to 2 Torr.

Performed a 20-minute vacuum rise test to ensure system is dehydrated and leak free.

Recharge the system with the correct charge weight in liquid form into the high side of the system to prevent damage to the compressor.

Let the system stand for 10 minutes so the liquid charge settles before starting the compressor to avoid flood back damage.

Run the system for 15 minutes to allow the system to stabilise before recording all running pressure and temperatures.

When system reaches design temperature, tidy up tools and materials and hand over to client, explaining what I have done.

Commentary

Demonstrates a thorough understanding of maintenance processes and underpinning knowledge. The candidate clearly knows the legislation that underpins activities within the process such as the British standard for pressure and leak and testing.

Maintenance report is clear and detailed. The process is accurate and supported by reasoning for the method taken to rectify the fault.

Candidate evidence

Practical Observation Form – Fault diagnosis, decommissioning and fault rectification.

Assessment ID	Qualification number
8710-358	8710-38
Candidate name	Candidate number
Candidate A	12345
Centre name	Assessment themes
City & Guilds	Health and safety, systems and components, working with faults

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

Task	Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.
Fault diagnosis and customer discussion	Candidate displays very good customer interaction with positive body language and asked questions with appropriate tone along with good use of eye contact that put the customer at ease The candidate asked various meaningful questions to gain an insight into the fault and explained well to the customer that the responses to the questions were allowing an insight into the possible fault and diagnostic assessments of the issue. The candidate used and set the multimeter and insulation tester correctly and in the correct sequence taking a necessary precaution to prevent electric shock. By this method the candidate was able to identify the compressor faults quickly and confidently reassuring the customer at all times. The candidate selected an appropriate repair method and was focused and methodical in their approach to the maintenance repair carrying out the task confidently explained the process that they would carry out in good time and no damage to customer property.
Decommissioning	Candidate follows a logical sequence for decommissioning. Candidate purged all lines and recovery unit minimizing the loss of refrigerant to the atmosphere and self-cleared the recovery unit on completion. The candidate checked the maximum fill weight of the cylinder before recovery and labeled the cylinder with the refrigerant type. The waste transfer note and F-Gas log sheet were completed without prompting by the assessor.

Task	Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.
Fault rectification	Candidate implemented all the health and safety preparations required to take care of components and customer property, ensuring warning notices and barriers were in place as appropriate to eliminate any trips/slips or falls. Candidate follows a methodical and logical sequence, recovering and storing the waste refrigerant correctly, prior to selecting the correct tools to remove and replace the defective component. The candidate completed the repair efficiently without error and in good time, checking the completed repair.

Assessor signature	Date
A. Assessor	26.02.21

Photographic evidence

Photo: 14	Disassembly takes place according to manufacturer's instructions. No damage is caused during disassembly. All components placed safely away from the work being undertaken. Previous damage to be noted
Photo:15	Clearly shows all pipe connections to the compressor are expertly unbrazed and there is no collateral damage to the compressor housing area and associated wiring.
Photo:16	Clearly shows compressor re-installed with no heat or mechanical damage to pipework, wiring, controls or casing.
Photo: 17	Clearly shows nitrogen cylinder, regulator and line connection to the condensing unit. Line should be shown to be safely routed, that nitrogen cylinder is secured and not interfering with the job.

Photo:18	A leak test procedure. It should include the fluid and or method used.
Photo:19	A Torr gauge correctly connected should show a reading of 2 Torr or less.
Photo:20	Shows charging of system. Cylinder should be secure, on scales and sited to avoid interference with the charging process, gauge manifold set should be correctly installed with sensible routing of hoses.
Photo:21	Reassembly of the condensing unit has been completed with no damage to the casing, that it is clean, and all fasteners are used.
Photo:22	Cleaning of an evaporator coil using an approved spray. Unit should be safely isolated during the procedure; drains should be checked to ensure cleaner can quickly escape as well as rinsing water able to also escape.

Photo:23	A photo showing a leak test procedure. It should include the fluid and or method used.
Photo:24	Should show temperature and airflow instrumentation correctly used and showing readings within the expected range.

Commentary

Candidate was confident during the discussion with the customer, maintaining eye contact and open body language throughout.

Candidate asked appropriate questions to determine the cause of the fault.

The candidate demonstrated excellent knowledge and understanding of fault diagnosis and process. Tools were selected correctly and used effectively. The repair followed a methodical order and was completed first time.

Candidate demonstrated good knowledge of F Gas legislation for decommissioning and commissioning of the system and completed legislative paperwork in detail.

Candidate follows correct process for the decommissioning and demonstrates an ability to sequence tasks logically. The process for safe disposal of waste was carried out with consideration to customer property and all components were recycled correctly.

Reference is made to manufacturer's guidance at all relevant stages throughout the task.

The T Level is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.