

# TEST PROJECT REFRIGERATION AND AIR CONDITIONING

WSC2019\_TP38\_EN\_V3

## PART A - DESCRIPTION OF THE MODULES, SPECIFICATIONS AND COMPETITOR INSTRUCTIONS

### Competitor

- Name \_\_\_\_\_
- Country \_\_\_\_\_





## CONTENTS

This Test Project consists of the following documentation/files:

- |                                  |  |
|----------------------------------|--|
| 1. WSC2019_TP38_EN_Part A.doc    | Description of the modules, specifications and competitor instructions |
| 2. WSC2019_TP38_EN_Part B.doc    | Test project and equipment manufacturers' drawings and instructions    |
| 3. WSC2019_TP38_BB_A4_01_EN.pdf  | Refrigeration system piping diagram                                    |
| 4. WSC2019_TP38_BB_A4_02_EN.pdf  | Power circuit diagram  |
| 5. WSC2019_TP38_BB_A4_03_EN.pdf  | Control circuit diagram  |
| 6. WSC2019_TP38_BB_A4_04_EN.pdf  | Electrical control panel layout  |
| 7. WSC2019_TP38_BB_A4_06_EN.pdf  | Control panel terminal diagram   |
| 8. WSC2019_TP38_BB_A4_07_EN.pdf  | Refrigeration system components layout                                 |
| 9. WSC2019_TP38_BB_A4_08_EN.pdf  | Ice rink coil  |
| 10. WSC2019_TP38_BB_A4_09_EN.pdf | Hot gas heat exchanger   |

## INTRODUCTION

This Test Project was developed by Independent Designers and will be released by the Skill Competition Manager and/or the Independent Test Project Designer/Team to the:

- Experts at the Competition (C-4)
- Competitors at the Competition (C-2)

This Test Project reflects international best practice as described by the Technical Description and the WorldSkills Standards Specification. The Test Project's Marking Scheme will only assess and allocate marks to those skills that are set out in the Standards Specification.

## TEST PROJECT DOCUMENTATION

The Test Project is a series of standalone modules and consists of the following two (2) parts:

- Part A - Description of the modules, specifications and competitors
- Part B – Test project and equipment manufacturers' drawings and instructions.

### Part A - Description of the modules, specifications and competitors

This contains all of the competition details for each module, including the task description and specifications, time limits, instructions to competitor and marking scheme summary. This will be provided to all participating Experts at the Competition C-4 to enable it to be translated into the Competitor's language and presented to the Competitor at C-2.

## **Part B - Equipment manufacturers' drawings and instructions**

This contains the test project and equipment manufacturers' drawings, instructions and specifications of the major equipment to be used in the competition. The details of the equipment were released online by WorldSkills to the participating countries April 2019 to enable relevant manufacturers' instructions to be sourced by the Experts and translated into the Competitor's language if needed and provided to Competitors prior to the competition.

### **Additional Information**

Additional information will be provided to all Competitors at the Familiarisation Session prior to start of the competition, including the Competitor's competition timetable.

# **DESCRIPTION OF PROJECT AND TASKS**

## **TEST PROJECT MODULES**

The Test Project is a series of standalone modules.

There are five (5) Modules to complete in the 23-hour competition.

A) Component Fabrication	13.5 Marks Time Allowed 3.0 Hrs
B) Refrigeration System Installation and Commissioning	50 Marks Time Allowed 16.0 Hrs
C) Air Conditioning System Electrical Fault Finding	12 Marks Time Allowed 1.0 Hr
D) Air Conditioning System Refrigeration Fault Finding	10 Marks Time Allowed 1.0 Hr
E) Air Conditioning System Refrigerant Recovery and Repair	14.5 Marks Time Allowed 2.0 Hrs

# MODULE A - COMPONENT FABRICATION AND BRAZING

MAXIMUM TIME ALLOWED - 3 HOURS

13.5 MARKS

<b>Start Time:</b>	<b>Expert:</b>	<b>Competitor:</b>
<b>Finish Time:</b>	<b>Expert:</b>	<b>Competitor:</b>
<b>Time Taken:</b>		

The Competitor and expert will record the **START** and **FINISH TIMES** above for this module.

## SCOPE

The Competitors are required to fabricate copper tubing as part of the refrigerant circuit to form the:

- Evaporator coil, to be installed during module B into the Ice Tank
- Hot gas side heat exchanger, be installed during Module B into the Heat Recovery Tank

The coils are to be constructed according the drawings listed below.

## TIMING

All Competitors are to complete the copper tubing fabrication at the same time in the morning of Day 1, this will allow for marking to take place later that day.

Any Competitors that do not finish Module A in the allocated time will be required to submit the unfinished project for assessment. Any Competitor who does not complete Module A in the required time (3 hours) will be allowed to complete it after it is assessed and handed back to them during Module B – no additional time will be allowed for either Module A or Module B for those who do not complete the fabrication in the allotted time.

## ASSESSMENT

Competitors will be assessed as per technical description; the marking scale will reflect dimensions and tolerances for assessment in addition to the quality of brazed joints.

Competitors will receive additional points for completing this module in less than the allocated time, as defined in the marking scheme.

## DRAWINGS

- WSC2019\_TP38\_BB\_A4\_08\_EN.pdf Ice rink coil
- WSC2019\_TP38\_BB\_A4\_09\_EN.pdf Hot gas heat exchanger

## COMPONENTS

Components to be installed are shown in the drawings.

**Experts Comments:**

<b>Fabrication</b>	Expert 1 Initials and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:
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# MODULE B - REFRIGERATION SYSTEM INSTALLATION AND COMMISSIONING

**MAXIMUM TIME ALLOWED - 16 HOURS**

**50.0 MARKS**

## SCOPE

Competitors are to install a refrigeration system to refrigerate a small ice tank and use the hot gas side to heat water. This system shows the potential of a refrigerant circuit to make ice and recover that heat to produce hot water.

The Competitors are required to use the supplied components along with the coils fabricated in Module A to form a refrigeration system for cooling down water to form ice and heat water with the hot gas.

When the hot water reaches a fixed temperature, the system will activate solenoid valves to direct the hot gas direct to the air-cooled condenser.

A crankcase pressure regulator is used to prevent excessive compressor current on start up.

A hot gas bypass valve is used to ensure suction pressure does not drop below design.

Refrigerant is R134a.

Competitors are required to connect all components to a prewired electrical panel

## TIMING

Competitors are to all complete the installation over 4 days of the competition as listed below.

### Day 1

- A. The Fabrication module A must be handed to the Expert for marking after the allocated 3 hours
- B. The following major components must be mounted per the diagram:

WSC2019\_TP38\_BB\_07\_A4\_EN.pdf Refrigeration system components layout diagram:

- a. Compressor
- b. Air cooled condenser
- c. Liquid receiver
- d. Suction accumulator
- e. Electrical Control box
- f. Pressure controls

- C. Pressure controls must be set to requirements

Items B and C will be marked by the Experts at the end of Day 1.

### Day 2

- A. All refrigerant pipework and components must be installed per the refrigeration system drawing:

- WSC2019\_TP38\_BB\_A4\_01\_EN.pdf Refrigeration system piping diagram

Do NOT install insulation on the pipework or components until after they have been marked.

- B. The refrigeration system must be pressure tested to the required pressure and any leaks rectified.

What ever you have completed of Items A and B at the end of Day 2 will be marked by the Experts at the end of that day. What ever you have NOT completed, will be marked by the Experts at the end of Day 3.

### Day 3

- A. The refrigeration system must be evacuated to the required vacuum.
- B. All electrical cables and wiring must be installed per the electrical drawings:
  - WSC2019\_TP38\_BB\_A4\_02\_EN.pdf      Power circuit diagram
  - WSC2019\_TP38\_BB\_A4\_03\_EN.pdf      Control circuit diagram
  - WSC2019\_TP38\_BB\_A4\_04\_EN.pdf      Electrical control panel layout
  - WSC2019\_TP38\_BB\_A4\_05\_EN.pdf      Electrical control panel dimensions
  - WSC2019\_TP38\_BB\_A4\_06\_EN.pdf      Control panel terminal diagram

What ever you have completed of Items A and B at the end of Day 3 will be marked by the Experts at the end of that day. What ever you have NOT completed, will be marked by the Experts at the end of Day 4.

### Day 4

- A. The refrigeration system must be commissioned to the design specifications with the ice tank frozen and left running and displayed.

## ASSESSMENT

Competitors will be assessed as per Technical Description and the WorldSkills Standard Specification with particular weighting on the commissioning and operation of the project.

Each task will be assessed by the Experts at the end of the allocated day even if the Competitor has not completed it.

## DRAWINGS

1. WSC2019\_TP38\_BB\_A4\_01\_EN.pdf Refrigeration system piping diagram
2. WSC2019\_TP38\_BB\_A4\_02\_EN.pdf Power circuit diagram
3. WSC2019\_TP38\_BB\_A4\_03\_EN.pdf Control circuit diagram
4. WSC2019\_TP38\_BB\_A4\_04\_EN.pdf Electrical control panel layout
5. WSC2019\_TP38\_BB\_A4\_06\_EN.pdf Control panel terminal diagram
6. WSC2019\_TP38\_BB\_A4\_07\_EN.pdf Refrigeration system components layout
7. WSC2019\_TP38\_BB\_A4\_08\_EN.pdf Ice rink coil
8. WSC2019\_TP38\_BB\_A4\_09\_EN.pdf Hot gas heat exchanger

## COMPONENTS

Components to be installed are specified in the Infrastructure List.

## SYSTEM DESIGN SPECIFICATIONS

The following system design specifications for the installation should be used for commissioning and control setting and are as follows:

- Refrigerant = R134a
- Maximum ambient temperature = 35°C Db, 28°C Wb
- Design saturated suction temperature = -15 °C
- Suction line pressure drop = 1 K

## CONTROL AND SAFETY SETTINGS

- Dual Pressure Control
  - Low Pressure cut off 5K lower than design saturated suction temperature (SST) and cut in at -10°C saturated suction temperature
  - High Pressure cut out when the condensing temperature reaches 55°C and cut in when the condensing temperature reaches 40°C
- High Pressure Control is to cut in the condenser fan when the condensing temperature reaches 45 °C and cut out when the condensing temperature reaches 35°C
- Crankcase Pressure Regulator is to limit the compressor current to a maximum of 11 amps
- Hot Gas Bypass Valve is to maintain -15°C saturated suction temperature and limit temperature cycling to safety only. The unit should run continually and not cycle on and off.
- Ice Tank Temperature controller is to cut out at -17 °C and cut in at -10 °C
- Heat Recovery Tank Temperature controller is to cut out at 46 °C to stop heating the water and cut in at 35 °C to start heating water again.



# INSTALL AND COMMISSION REFRIGERATION SYSTEM

All Competitors will be required to perform the following tasks to complete this module.

A number of Tasks must be either observed and/or signed off by Experts.

Task 6 has an Expert sign off sheet which needs to be filled in and signed prior to moving ahead on this task

## TASK 1. INSTALL REFRIGERATION SYSTEM

All Competitors will be supplied with all necessary equipment and materials to complete the installation of the refrigeration system in accordance with test project drawings and World Skills International Refrigeration and Air Conditioning Standard Specification. Refer to the relevant project drawings to complete this task.

**The following major components must be mounted by the end of Day 1:**

- Compressor
- Air cooled condenser
- Liquid receiver
- Suction accumulator
- Electrical control box
- Pressure controls

## TASK 2. SET PRESSURE CONTROLS

**This must be carried out by the end of Day 1.**

Competitors are to bench set the Dual Pressure Control and the High Pressure Control in accordance with the design specifications supplied and complete the following reports. Please indicate measurement units by ticking (✓) the appropriate boxes.

**This Task is to be carried out and the report filled in by COMPETITORS.**

These settings will be assessed and signed off by the Experts at the end of Day 1.

### Dual Pressure Control

- |                       |       |                              |                              |                              |   |
|-----------------------|-------|------------------------------|------------------------------|------------------------------|---|
| ○ LP Control Cut In:  | _____ | <input type="checkbox"/> kPa | <input type="checkbox"/> psi | <input type="checkbox"/> bar | <input type="checkbox"/> kg/cm <sup>2</sup> |
| ○ LP Control Cut Out: | _____ | <input type="checkbox"/> kPa | <input type="checkbox"/> psi | <input type="checkbox"/> bar | <input type="checkbox"/> kg/cm <sup>2</sup> |
| ○ HP Control Cut Out: | _____ | <input type="checkbox"/> kPa | <input type="checkbox"/> psi | <input type="checkbox"/> bar | <input type="checkbox"/> kg/cm <sup>2</sup> |
| ○ HP Control Cut In:  | _____ | <input type="checkbox"/> kPa | <input type="checkbox"/> psi | <input type="checkbox"/> bar | <input type="checkbox"/> kg/cm <sup>2</sup> |

### High Pressure Control

- |            |       |                              |                              |                              |   |
|------------|-------|------------------------------|------------------------------|------------------------------|---|
| ○ Cut Out: | _____ | <input type="checkbox"/> kPa | <input type="checkbox"/> psi | <input type="checkbox"/> bar | <input type="checkbox"/> kg/cm <sup>2</sup> |
| ○ Cut In:  | _____ | <input type="checkbox"/> kPa | <input type="checkbox"/> psi | <input type="checkbox"/> bar | <input type="checkbox"/> kg/cm <sup>2</sup> |

**Experts Comments:**

### EXPERTS SIGN OFF

Pressure Control Setting

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

### TASK 3. PRESSURE TEST SYSTEM

**All refrigerant pipework and components should be installed and pressure tested by the end of Day 2.**

**Do NOT install insulation on the pipework or components until after they have been marked.**

Carry out a staged pressure test of the refrigeration system (R134a) in accordance with manufacturer's equipment instructions and WorldSkills standards.

The pressure test point should not drop more than the equivalent of 1°C from the starting point in the fifteen (15) minutes after the pressure test is isolated from the Nitrogen cylinder.

If the pressure test has not been achieved successfully, the Competitor can continue to fix the leak/s and achieve the pressure test; however, the full marks for Pressure Test will be lost.

**Pressure test point should be equivalent to 55°C saturation temperature for both the high and low sides of the system.**

**This Task is to be carried out and the report filled in by COMPETITORS under the supervision of the Expert/s**

#### PRESSURE TEST ATTEMPT #1

Starting test pressure: \_\_\_\_\_ □ kPa □ psi □ bar □ kg/cm<sup>2</sup>

Starting Time: \_\_\_\_\_

Test pressure after standing time: \_\_\_\_\_ □ kPa □ psi □ bar □ kg/cm<sup>2</sup>

Finishing Time: \_\_\_\_\_

#### PRESSURE TEST ATTEMPT #2

Starting test pressure: \_\_\_\_\_ □ kPa □ psi □ bar □ kg/cm<sup>2</sup>

Starting Time: \_\_\_\_\_

Test pressure after standing time: \_\_\_\_\_ □ kPa □ psi □ bar □ kg/cm<sup>2</sup>

Finishing Time: \_\_\_\_\_

**Experts Comments:**

### EXPERTS SIGN OFF

Refrigeration System Pressure Test

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## TASK 4. INSTALL ELECTRICAL SYSTEM

**This should be carried out by the end of Day 3.**

All Competitors will be supplied with all necessary equipment and materials to complete the installation of the electrical system in accordance with test project drawings and World Skills International Refrigeration and Air Conditioning Standard Specification.

Refer to the relevant project drawings to complete this task.

The main cable duct should be installed on the back (rear) of the vertical panel.

### EXPERTS SIGN OFF

Electrical Installation Completed, but not Tested

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## TASK 5. EVACUATION

**This should be carried out by the end of Day 3.**

**The Task must NOT be commenced until the Experts have Signed Off Task 3 Pressure Test.**

Evacuate the system in accordance with manufacturer's instructions and WorldSkills Standards Specifications using the Deep Vacuum Method to hold a vacuum of at least 1000 microns (133 kPa or 1,333 mbar absolute of mercury after the vacuum pump is isolated from the system under test.

The records evacuation pressure above should not rise more than 500 microns in the Ten (10) minutes after the vacuum pump is isolated from the system under test.

**This Task is to be carried out and the report filled in by COMPETITORS under the supervision of the Expert/s**

### EVACUATION TEST ATTEMPT #1

Starting evacuation level: \_\_\_\_\_ □ microns

Starting Time: \_\_\_\_\_

Evacuation level after standing time: \_\_\_\_\_ □ microns

Finishing Time: \_\_\_\_\_

### EVACUATION TEST ATTEMPT #2

Starting evacuation level: \_\_\_\_\_ □ microns

Starting Time: \_\_\_\_\_

Evacuation level after standing time: \_\_\_\_\_ □ microns

Finishing Time: \_\_\_\_\_

**Experts Comments:**

## EXPERTS SIGN OFF

Refrigeration Evacuation Test

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## TASK 6. BREAK THE VACUUM

**The Task must NOT be commenced until the Experts have Signed Off Task 5 Evacuation and the Electrical Installation work is completed to ensure the sustainable use of refrigerant.**

Break the vacuum by charging the refrigeration system with 1.5 kg (3.3 lb) of R134a liquid refrigerant as the initial charge in accordance with acceptable trade and environmental practices.

**This Task is to be carried out and the report filled in by COMPETITORS under supervision by Expert/s**

Bottle weight prior to charging: \_\_\_\_\_ □ kg    □ lb

Bottle weight at completion of charging: \_\_\_\_\_ □ kg    □ lb

Weight of the refrigerant added: \_\_\_\_\_ □ kg    □ lb

**Experts Comments:**

## TASK 7. ELECTRICAL TESTING

Perform all necessary safety checks to ensure the installed refrigeration system's is safe to energize and record the results below:

**This may be carried out in Day 3 or 4, but must be completed successfully before commencing Task 8 Finalising the Refrigerant Charge.**

- i. Electrical Supply Voltage
  - i. Active to Earth \_\_\_\_\_ volts
  - ii. Neutral to Earth \_\_\_\_\_ volts
  - iii. Active to Neutral \_\_\_\_\_ volts
  
- ii. Earth continuity from supply lead to:
  - i. Control panel \_\_\_\_\_  $\Omega$
  - ii. Compressor \_\_\_\_\_  $\Omega$
  - iii. Solenoid valves \_\_\_\_\_  $\Omega$  \_\_\_\_\_  $\Omega$
  - iv. Fan motor \_\_\_\_\_  $\Omega$
  
- iii. Continuity from supply lead to:
  - i. Control panel's Active \_\_\_\_\_  $\Omega$
  - ii. Control panel's Neutral \_\_\_\_\_  $\Omega$
  
- iv. Using an Ohm-meter measure the refrigeration system's resistance between:
  - i. Active and Neutral \_\_\_\_\_  $\Omega$
  - ii. Active and Earth \_\_\_\_\_  $\Omega$
  - iii. Neutral and Earth \_\_\_\_\_  $\Omega$
  
- v. Based on your tests, is the unit safe to connect to the electrical supply?
 

☐ Yes or ☐ No

Because:

  - i. ☐ It is Electrically Safe
  - ii. ☐ The earth is not connected
  - iii. ☐ The polarity is not correct
  - iv. ☐ There is a short between Active and Earth
  - v. ☐ There is a short between Neutral and Earth
  
- vi. Carryout any repairs necessary to make the unit safe to connect to the electrical supply under the supervision of the Experts

### These results will be assessed and signed off by the Experts.

All wiring inspected by Expert prior to energizing: ☐ Yes ☐ No

Electrical safety checks performed prior to energizing: ☐ Yes ☐ No

**Experts Comments:**

#### EXPERTS SIGN OFF

Refrigeration System Electrical Test

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

### TASK 8. FINALISING THE REFRIGERANT CHARGE

The Task must NOT be commenced until the Experts have Signed Off Task 7 Electrical Testing.

1. Operate the refrigeration system, check its operating conditions and add additional refrigerant vapour as required until the system's optimum charge is achieved.
2. Record the final details of the refrigerant charge below.

Bottle weight prior to charging: \_\_\_\_\_ ☐ kg ☐ lb

Bottle weight at completion of charging: \_\_\_\_\_ ☐ kg ☐ lb

Weight of the refrigerant added: \_\_\_\_\_ ☐ kg ☐ lb

**Experts Comments:**

#### EXPERTS SIGN OFF

Charging Refrigerant

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## TASK 9. COMMISSION THE SYSTEM

**The Task must NOT be commenced until the Experts have Signed Off Task 7 Charging with Refrigerant**

Competitors are to commission the system for operation in accordance with the design specifications supplied.

Please fill out the following commissioning document with the system fully operational and operating close to the design saturated suction temperature. Please indicate units by checking appropriate boxes.

**This Task is to be carried out and the report filled in by COMPETITORS**

Ambient Temperature:	_____	<input type="checkbox"/> Celsius	<input type="checkbox"/> Fahrenheit
Ice Tank Ice/Water Temperature	_____	<input type="checkbox"/> Celsius	<input type="checkbox"/> Fahrenheit
Heat Recovery Tank Water Temperature	_____	<input type="checkbox"/> Celsius	<input type="checkbox"/> Fahrenheit
Refrigerant Type:	_____		
Mass of Refrigerant Charge:	_____	<input type="checkbox"/> grams	<input type="checkbox"/> pounds
Suction Pressure:(gauge)	_____	<input type="checkbox"/> kPa	<input type="checkbox"/> psi <input type="checkbox"/> bar <input type="checkbox"/> kg/cm <sup>2</sup>
Evaporation Temperature	_____	<input type="checkbox"/> Celsius	<input type="checkbox"/> Fahrenheit
Discharge Pressure:(gauge)	_____	<input type="checkbox"/> kPa	<input type="checkbox"/> psi <input type="checkbox"/> bar <input type="checkbox"/> kg/cm <sup>2</sup>
Condensing Temperature	_____	<input type="checkbox"/> Celsius	<input type="checkbox"/> Fahrenheit
Liquid Line Subcooling:	_____	<input type="checkbox"/> Kelvin	<input type="checkbox"/> Fahrenheit Degrees
Thermostatic Expansion Valve Superheat:	_____	<input type="checkbox"/> Kelvin	<input type="checkbox"/> Fahrenheit Degrees
Total Suction Superheat:	_____	<input type="checkbox"/> Kelvin	<input type="checkbox"/> Fahrenheit Degrees
Hot Gas Bypass Valve setting:	_____	<input type="checkbox"/> kPa	<input type="checkbox"/> psi <input type="checkbox"/> bar <input type="checkbox"/> kg/cm <sup>2</sup>
Compressor Operating Current:	_____	<input type="checkbox"/> Amps	

**These results will be assessed and signed off by the Experts at the end of Day 4.**

**Experts Comments:**

### EXPERTS SIGN OFF

Refrigeration System Commissioning

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

# MODULE C - AIR CONDITIONING SYSTEM ELECTRICAL FAULT FINDING

Maximum time is 1.0 hour

12.0 MARKS

<b>Start Time:</b>	<b>Expert:</b>	<b>Competitor:</b>
<b>Finish Time:</b>	<b>Expert:</b>	<b>Competitor:</b>
<b>Time Taken:</b>		

The Competitor and expert will record the START and FINISH TIMES above for this module.

This Task is to be carried out and the report filled in by COMPETITORS under supervision by Expert/s

There are electrical fault/s on the air conditioning system.

Competitors will receive additional points for completing this module in less than the allocated time, as defined in the marking scheme.

## 1. Electrical Safety Tests

Carry out the following electrical tests to ensure it is safe to connect to the electrical supply and record the results below:

- a. Electrical Supply Voltage at the power outlet.
  - i. Active to Earth \_\_\_\_\_ volts
  - ii. Neutral to Earth \_\_\_\_\_ volts
  - iii. Active to Neutral \_\_\_\_\_ volts
- b. Air Conditioner's earth continuity.
  - i. Earth pin on the supply cable to outdoor unit frame \_\_\_\_\_  $\Omega$
  - ii. Earth pin on the supply cable to indoor unit frame \_\_\_\_\_  $\Omega$
  - iii. Earth pin on the supply cable to the compressor \_\_\_\_\_  $\Omega$
- c. Air Conditioner's outdoor unit supply continuity
  - i. Active pin on the supply cable to the outdoor unit's terminal \_\_\_\_\_  $\Omega$
  - ii. Neutral pin on the supply cable to the outdoor unit's terminal \_\_\_\_\_  $\Omega$
- d. Using an Ohm-meter measure the resistance on the supply cable to the air conditioning unit between Earth and:
  - i. Active \_\_\_\_\_  $\Omega$
  - ii. Neutral \_\_\_\_\_  $\Omega$
- e. Based on your tests, is the unit safe to connect to the electrical supply? ☐ Yes or ☐ No  
Because:
  - i. ☐ It is Electrically Safe
  - ii. ☐ The earth is not connected
  - iii. ☐ The polarity if not correct
  - iv. ☐ The Active is not connected
  - v. ☐ The Neutral is not connected



- c. Re-connect any wiring you removed and ensure the unit safe to connect to the electrical supply under the supervision of the Experts.

### EXPERTS SIGN OFF

#### Electrical Safety Tests

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

### Electrical Compressor Tests

- a. Each Competitor is to disconnect the cable connection plug to the compressor and take resistance readings from it and record their values below.

Compressor Wiring Resistance readings

- i. Yellow to Blue \_\_\_\_\_  $\Omega$
- ii. Blue to Red \_\_\_\_\_  $\Omega$
- iii. Red to Yellow \_\_\_\_\_  $\Omega$

- b. Insulation Resistance readings using an Insulation Resistance Tester (IR) set on 500 volts

- i. Yellow to E \_\_\_\_\_  $M\Omega$
- ii. Blue to E \_\_\_\_\_  $M\Omega$
- iii. Red to E \_\_\_\_\_  $M\Omega$

#### c. Conclusions

Based on your reading above, do the compressor motor windings have a:

- i. Short Circuit ☐ Yes ☐ No
- ii. Open Circuit ☐ Yes ☐ No
- iii. Earth Leakage ☐ Yes ☐ No
- iv. Is the compressor electrically safe to connect to operate? ☐ Yes ☐ No

- d. Reconnect the electrical connections to the air conditioning unit's compressor as they were originally connected before you carried out these tests.

- i. Completed correctly ☐ Yes ☐ No

### EXPERTS SIGN OFF

#### Electrical Compressor Tests

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## 2. Electrical Fault Finding

Each Competitor will;

- i. Connect the air conditioning unit to the supply and turn it on to cooling mode

Allow up to 5 minutes delay for the outdoor unit to start operating.

- ii. Observe its operation and record below if the following components are operating after 5 minutes:

- Indoor fan    ☐ Yes    ☐ No
- Outdoor fan    ☐ Yes    ☐ No
- Compressor    ☐ Yes    ☐ No

- iii. Determine the fault and identify it on the list below with a tick ✓:

Note: The unit's electronic controller is not faulty.

- ☐ No active supply to outdoor unit
- ☐ No neutral supply to outdoor unit
- ☐ Remote control not operating
- ☐ Compressor open circuit
- ☐ No communication supply to outdoor unit
- ☐ High pressure control open circuit
- ☐ No active supply to indoor unit
- ☐ No neutral supply to indoor unit
- ☐ Low pressure control open circuit
- ☐ Solenoid coil open circuit
- ☐ Indoor fan motor open circuit
- ☐ Outdoor fan motor open circuit

Once the fault is identified, the Experts will sign off this Task below.

## 3. Re-assemble Units

Re-connect any wiring and refit covers to return the units back to the condition they were in before you commenced this module.

## Experts Comments

### EXPERTS SIGN OFF

**Air Conditioning System  
Electrical Fault Finding**

Expert 1 Initials and Country:  
Expert 2 Initials and Country:  
Expert 3 Initials and Country:

## MODULE D - AIR CONDITIONING SYSTEM REFRIGERATION FAULT FINDING

Maximum time is 1.0 hour

10 MARKS

<b>Start Time:</b>	<b>Expert:</b>	<b>Competitor:</b>
<b>Finish Time:</b>	<b>Expert:</b>	<b>Competitor:</b>
<b>Time Taken:</b>		

1. The Competitor and expert will record the **START and FINISH TIMES** above.

Competitors will receive additional points for completing this module in less than the allocated time, as defined in the marking scheme.

2. Operate the air conditioning unit on Cooling mode with High fan speed and record its operating conditions below:

- Ambient Temperature: \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit
- Return Air Dry Bulb Temperature: \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit
- Supply Air Dry Bulb Temperature: \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit
- Indoor Fan Speed: ☐ High ☐ Medium ☐ Low
- Refrigerant Type: \_\_\_\_\_
- Suction Gauge Pressure: \_\_\_\_\_ ☐ kPa ☐ psi ☐ bar ☐ kg/cm<sup>2</sup>
- Saturated Suction Temperature \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit
- Total Suction Superheat: \_\_\_\_\_ ☐ Kelvin ☐ Fahrenheit
- Outdoor Unit's Operating Current: \_\_\_\_\_ ☐ Amps

3. Determine the refrigeration fault and identify it on the list below by a tick ✓:

- ☐ Under charge of refrigerant
- ☐ Over charge of refrigerant
- ☐ Non-condensable mixed with refrigerant
- ☐ Blockage in liquid line at the outdoor unit
- ☐ Blockage in liquid line at the indoor unit
- ☐ Blockage in suction line at the outdoor unit
- ☐ Blockage in suction line at the indoor unit
- ☐ Liquid line connected to incorrect outdoor unit port
- ☐ Suction line connected to incorrect outdoor unit port
- ☐ Compressor inefficient (not pumping)
- ☐ Blocked or restricted refrigerant metering device
- ☐ Incorrect refrigerant
- ☐ No fault

Once the fault is identified, the Experts will sign off your results below.

**Experts Comments:**

### EXPERTS SIGN OFF

**Air Conditioning System  
Refrigeration Fault Finding**

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

# MODULE E - AIR CONDITIONING SYSTEM REFRIGERATION REPAIR

Maximum time is 2.0 hours

14.5 MARKS

Start Time:	Expert:	Competitor:
Finish Time:	Expert:	Competitor:
Time Taken:		

1. To repair the fault on the air conditioning system, recover all of the refrigerant from the system and record mass removed below:

Reclaim bottle weight prior to reclaim: \_\_\_\_\_ ☐ kg ☐ lb

Reclaim bottle weight at completion of reclaim: \_\_\_\_\_ ☐ kg ☐ lb

Weight of the refrigerant reclaimed: \_\_\_\_\_ ☐ kg ☐ lb

**Experts Comments:**

2. Carry out any other actions required to repair the fault.
3. Pressure test of the system in accordance with manufacturer's equipment instructions and WorldSkills standards.

The pressure test point should not drop more than the equivalent of 1°C from the starting point in the fifteen (15) minutes after the pressure test is isolated from the Nitrogen cylinder.

If the pressure test has not been achieved successfully, the Competitor can continue to fix the leak/s and achieve the pressure test; however, the full marks for Pressure Test will be lost.

**Pressure test point should be equivalent to 55°C saturation temperature**

**This Task is to be carried out and the report filled in by COMPETITORS under the supervision of the Expert/s**

## PRESSURE TEST ATTEMPT #1

Starting test pressure: \_\_\_\_\_ ☐ kPa ☐ psi ☐ bar ☐ kg/cm<sup>2</sup>

Starting Time: \_\_\_\_\_

Test pressure after standing time: \_\_\_\_\_ ☐ kPa ☐ psi ☐ bar ☐ kg/cm<sup>2</sup>

Finishing Time: \_\_\_\_\_

## PRESSURE TEST ATTEMPT #2

Starting test pressure: \_\_\_\_\_ ☐ kPa ☐ psi ☐ bar ☐ kg/cm<sup>2</sup>

Starting Time: \_\_\_\_\_

Test pressure after standing time: \_\_\_\_\_ ☐ kPa ☐ psi ☐ bar ☐ kg/cm<sup>2</sup>

Finishing Time: \_\_\_\_\_

## Experts Comments:

### EXPERTS SIGN OFF

Refrigeration Pressure Test

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## 4. Evacuation

**This Task must NOT be commenced until the Experts have Signed Off Task 3 Pressure Test.**

Evacuate the system in accordance with manufacturer's instructions and WorldSkills Standards Specifications using the **Deep Vacuum Method** to hold a vacuum of at least 1000 microns (133 kPa or 1,333 mbar absolute of mercury after the vacuum pump is isolated from the system under test.

The records evacuation pressure above should not rise more than 500 microns in the Ten (10) minutes after the vacuum pump is isolated from the system under test.

**This Task is to be carried out and the report filled in by COMPETITORS under the supervision of the Expert/s**

### EVACUATION TEST ATTEMPT #1

Starting evacuation level: \_\_\_\_\_ □ microns

Starting Time: \_\_\_\_\_

Evacuation level after standing time: \_\_\_\_\_ □ microns

Finishing Time: \_\_\_\_\_

### EVACUATION TEST ATTEMPT #2

Starting evacuation level: \_\_\_\_\_ □ microns

Starting Time: \_\_\_\_\_

Evacuation level after standing time: \_\_\_\_\_ □ microns

Finishing Time: \_\_\_\_\_

## Experts Comments:

### EXPERTS SIGN OFF

Refrigeration Evacuation Test

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## 5. Charge refrigerant

**The Task must NOT be commenced until the Experts have Signed Off Task 5 Evacuation.**

Charge the system with the required weight of R410a refrigerant to ensure operation according to manufacturer's specification of 830 grams (29.3 ounces) in accordance with acceptable trade and environmental practices.

**This Task is to be carried out and the report filled in by COMPETITORS under supervision by Expert/s**

Bottle weight prior to charging: \_\_\_\_\_ ☐ kg    ☐ lb

Bottle weight at completion of charging: \_\_\_\_\_ ☐ kg    ☐ lb

Weight of the refrigerant added: \_\_\_\_\_ ☐ kg    ☐ lb

**Experts Comments:**

### EXPERTS SIGN OFF

Charging Refrigerant

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:

## 6 Commission the system

Competitors are to commission the system for operation in accordance with the manufacturers specifications supplied. Please fill out the following commissioning document with the system fully operational, on “Cooling” mode, indoor fan on highest speed and as close to operating temperatures as possible. Please indicate units by checking appropriate boxes.

Ambient Temperature: \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit

Return Air Dry Bulb Temperature: \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit

Supply Air Dry Bulb Temperature: \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit

Indoor Fan Speed: ☐ High ☐ Medium ☐ Low

Mode of Operation: ☐ Cooling ☐ Heating ☐ Dehumidification

Refrigerant Type: \_\_\_\_\_

Mass of Refrigerant Charge: \_\_\_\_\_ ☐ grams ☐ pounds

Suction Gauge Pressure: \_\_\_\_\_ ☐ kPa ☐ psi ☐ bar ☐ kg/cm<sup>2</sup>

Saturated Suction Temperature \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit

Suction line temperature at compressor inlet \_\_\_\_\_ ☐ Celsius ☐ Fahrenheit

Total Suction Superheat: \_\_\_\_\_ ☐ Kelvin ☐ Fahrenheit Degrees

Outdoor Unit's Operating Current: \_\_\_\_\_ ☐ Amps

### Experts Comments:

### EXPERTS SIGN OFF

Commissioning

Expert 1 Initials and Country:

Expert 2 Initials and Country:

Expert 3 Initials and Country:



# INSTRUCTIONS TO THE COMPETITOR

## TIME ALLOWED FOR EACH MODULE

To enable all Competitors to complete the Modules they must carry them out in the times allocated in the Competition Time Table.

## CHECK POINTS

While system pipe work and electrical wiring is being installed, the Competitor is free to work autonomously in a safe manner with most relevant assessments being completed outside of competition time.

However, Competitors **MUST** perform some tasks in the presence of the Experts as specified in the Test Project. Therefore, at various points in this competition you must ask the Experts to observe and check your work. Once checked the Experts must place their initial in a progress box as per the example below.

Electrical Installation Testing

- Expert 1 Initials and Country      CM   AUS
- Expert 2 Initials and Country      MF   UK
- Expert 3 Initials and Country      DO   IE

## INFORMATION CONCERNING SAFETY REQUIREMENTS

During the competition, all Competitors **MUST** follow the safety rules listed below along with the local Health, Safety and Environment requirements of the host country.

### SHOES

- Fully enclosed safety shoes or boots with protective toe caps must be worn at all times.

### CLOTHING

- Legs must be covered at all times, by either long work trousers or overalls.
- Upper body must be covered at all times.
- Arms must be covered with long sleeves within the workstation.

### SAFETY GLASSES

- Must be worn when necessary to protect your eyes.
- Must be worn when brazing, soldering, filing, reaming, hack sawing, drilling, grinding, and using refrigerant, dry nitrogen and compressed air.

### GLOVES

- Must be worn when brazing, using refrigerants, cutting, filing or hacksawing
- Electrical protection gloves must be worn when testing a live circuit

### ELECTRICAL

- Competitors must **NOT** switch on (apply power) to any electrical equipment until they receive permission from an Expert, except for hand power tools.

Any Competitor that is identified by 2 Experts as not wearing the correct safety attire or is engaging in any unsafe practice will be stopped and advised on the correct safety practice. If the unsafe working practice is repeated, the Experts may STOP the Competitor and report the issue to the chief or Deputy Chief Expert. The Competitor may not be allowed to continue until the safety issue is resolved. The Competitor will lose associated safety marks.

If the Competitor continues to ignore the safe working practice, they may be removed from the competition area for a safety briefing for ten minutes by the host country health, safety and environment representative, the time taken to complete the safety briefing will be considered to be a part of the Competitor's competition time.

## ADDITIONAL EQUIPMENT, MACHINERY, INSTALLATIONS AND MATERIALS REQUIRED

All required equipment and materials for the Test Project are specified in the Infrastructure List. Therefore, no additional equipment, machinery, installations or materials are listed below.

ITEM	QUANTITY	MATERIAL	DESCRIPTION	NOTES
Nil				

## MARKING SCHEME

This Test Project has as a marking scheme matching the assessment criteria as given in the Technical Description (Marking Summary). For each of these criteria a detailed list of aspects to be assessed have been defined and will be used by the Experts to assess the competitor's skills and the completed Test Project.

The Marking Scheme Summary will be provided for your information.