TEST PROJECT – REFRIGERATION AND AIR CONDITIONING

WSC2015_TP38_actual

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WSC2015

TEST PROJECT MODULES

There are Three (3) Modules to complete in the 20 hour competition.

A)	Component Fabrication	13.5 Marks Time Allowed 3.0 Hrs
B)	Refrigeration System Installation and Commissioning	49 Marks Time Allowed 13.0 Hrs
C)	Air Conditioning System Fault Find, Repair and Commissioning	37.5 Marks Time Allowed 4.0 Hrs

TEST PROJECT DOCUMENTATION

Section 1: Competitor Instructions – Competition Details

This contains all of the competition details, except for the specific information on the refrigeration and air conditioning systems to be used in the competition. This will be provided to all participating countries approximately six (6) months prior to the competition to enable it to be translated into the Competitor's language and passed onto the Competitor. This document will be superseded by Section 4 prior to the competition.

Section 2: Competitor Instructions – Manufacturers, Equipment and Materials Manuals

This contains the full operating manuals, wiring diagrams and specifications of the major equipment to be used in the competition. This will be provided to all participating countries approximately three (3) months prior to the prior to the competition to enable it to be translated into the Competitor's language and passed onto Competitors, all information will be available online via the WorldSkills Infrastructure List for competition

Section 3: Test Project Drawings

The drawings will be distributed with Section 1. The drawings may be altered as part of the 30% change to the project which will take place at the competition. The drawings are issued as a guide only and are finalized at the competition.

Section 4: Competition Instructions

This document supersedes Section 1 and will be provided to all Competitors at the Information Session prior to start of the competition and will include a 30% change to the test project described in Section 1, it will include or provide reference to:

- The Competitor's competition timetable
- Health, safety and environment requirements
- Category competition rules and procedures
- Refrigeration Competition Standards
- Additional information

Section 5: Marking Scale

The marking summary will be distributed with Section 2 approximately three months prior to the competition. The marking scale detail will be finalized by the Experts prior to the competition dependent on the availability of materials and equipment supplied by the host nation and the 30% change to the Test Project.

TIME ALLOWED FOR EACH MODULE

To enable all Competitors complete the Modules they will carry out the work at the same time. The

Competition Time Table in the Competitors Instructions Section 4 must be followed. Where system pipe work is installed, the Competitor is free to work autonomously in a safe manner with all relevant assessment being completed outside of competition time, pressure transducers may be used to ensure minimum pressure test and evacuation requirements are met by the Competitors. Competitors MUST perform all electrical testing in the presence of an Expert prior to energizing the installation.

CHECK POINTS

An important part of this competition are the procedures used to carry out various tasks. Therefore, at various points in this competition you must ask an Expert to observe and check your work. Once checked the Expert 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 work shoes or boots 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, when brazing and using refrigerant.

CLEAR 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 and using refrigerants

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 as not wearing the correct safety attire or is engaging in any unsafe practice will be stopped and advised on the correct safety practice by an Expert. If the unsafe working practice is repeated the Expert 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 minute 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.

COMPETITION DETAILS - MODULE A

COMPONENT FABRICATION

MAXIMUM TIME ALLOWED - 3 HOURS **13.5 MARKS**

SCOPE

The Competitors are required to fabricate a copper tubing circuit for the secondary refrigerant circuit that will form the ice rink surface, this coil will be incorporated into the design of the system at a later stage. The coil is constructed using 13 lengths of 1/2" copper tubing, fed by a 7/8" copper header as per supplied drawing. This entire unit will sit in the bottom of a tank and form the secondary refrigerant coil for the ice rink being installed in Module B.

TIMING

Competitors are to all complete the ice rink piping at the same time in the morning of C1, this will allow for marking to take place in the afternoon, any Competitors that do not finish Module A in the allocated time will be required to submit the unfinished project for assessment. Competitors will receive additional points for completing this module in less than the allocated time (as defined in the marking summary) providing that the fabricated component does not leak when pressure tested.

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. Fabricated component will be tested for leaks by pressure testing with dry nitrogen to ensure no leaks are present. 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.

DRAWINGS

R.001 Coil of Ice Rink

COMPONENTS

Components to be installed will include the following;

- Pre manufactured 7/8" header copper pipework

COMPETITION DETAILS - MODULE B

REFRIGERATION SYSTEM INSTALLATION AND COMMISSIONING

MAXIMUM TIME ALLOWED - 13 HOURS **49.0 MARKS**

SCOPE

Competitors are to install a refrigeration system to refrigerate a small scale ice rink, the system uses a secondary refrigerant to remove heat from the ice rink and mimics a small industrial plant commonly used to carry out a much larger duty.

The Competitors are required to use the supplied components along with the coil fabricated in Module A to form a low pressure flooded system that utilizes a brazed plate heat exchanger to refrigerate propylene glycol to remove heat from water to form the ice rink. A small condensing unit is used to draw vapour off the top of the vessel and compress and condense the refrigerant, an electric expansion valve is used to meter the refrigerant into the vessel. Two level switches are used to control the liquid level inside the vessel, a capacity control valve is used to ensure suction pressure does not drop below design. Refrigerant is R134a.

Secondary refrigerant circuit for ice rink is to be constructed using copper pipe, copper pipe will be used to form the secondary refrigerant pipe circuit joining heat exchanger, ice rink coil and glycol tank with a flexible hose connection used to connect the copper pipe to the circulating pump.

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

TIMING

Competitors are to all complete the installation over C1, C2 and C3. The secondary refrigerant circuit (glycol) pipework must be completed by the end of C2 for assessment overnight, the entire installation will be completed by the end of C3 for assessment. The completed project with ice rink frozen may be left running and displayed on C4.

ASSESSMENT

Competitors will be assessed as per technical description with particular weighting on the commissioning and operation of the project.

DRAWINGS

R.002 Primary refrigerant flow circuit

R.003 Secondary refrigerant flow circuit

R.004 General Installation View

R.005 Glycol Tank and Ice Rink

R.006 Low Pressure Vessel

R.007 Electrical Control Panel

R.008 Electrical Control Diagram

R.009 Electrical Power Diagram

R.010 Electrical Terminal Connections

COMPONENTS

Components to be installed will include the following;

- Basic air cooled condensing unit with liquid receiver ad oil separator
- Low pressure vessel
- Capacity control valve (Danfoss KVC)
- Electric expansion valve (Danfoss AKV)
- 2 x liquid level switches (Reed Switch)
- Brazed plate heat exchanger (Danfoss)
- Circulating pump (submersible type)
- Electrical switchboard
- Temperature controller (Danfoss)
- Data logging pressure transducer (Siemens)

SYSTEM DESIGN SPECIFICATIONS

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

SYSTEM SPECIFICATIONS

- Primary refrigerant = R134a
- Secondary refrigerant = Propylene Glycol (40% by volume)
- Maximum ambient temperature = 35°C Db, 28°C Wb
- Design saturated suction temperature = -15 °C
- Suction line pressure drop = 1 K
- Design Glycol temperature = -10°C supply to ice rink

CONTROL AND SAFETY SETTING

- Low Pressure Controller cut off 5K lower than design saturated suction temperature (SST).
- Low Pressure Controller cut in at -10 °C saturated suction temperature
- Capacity control valve to maintain -15 °C saturated suction temperature
- High Pressure cut out the system when the Condensing temperature reaches 55 °C
- Temperature controller cut out at -15 °C
- Temperature controller cut in at -10 °C
- Temperature sensor to be submerged in glycol tank

SYSTEM OPERATION

- Low level liquid level sensor to cycle on electric expansion valve
- High level liquid level sensor to cycle off electric expansion valve
- Temperature controller to cycle off expansion valve if glycol tank temperature falls below -15 °C
- Temperature controller to cycle on expansion valve if glycol tank temperature rises above -10 °C
- Capacity control valve set to maintain -15 °C saturated suction temperature and limit temperature cycling to safety only (unit should run continually and not cycle on and off)

INSTALL AND COMMISSION REFRIGERATION SYSTEM

All Competitors will be required to perform the following tasks to complete this module, task 6 has an Expert sign off sheet which needs to be filled in and signed prior to moving ahead on this task

1. INSTALL REFRIGERATION SYSTEM

All Competitors will supplied with all necessary equipment and materials to complete the installation of the refrigeration system in accordance with test project drawings and WorldSkills International Standard for Refrigeration and Air Conditioning.

Refer to the following project drawings to assist to complete this task

R.002 Primary refrigerant flow circuit

R.003 Secondary refrigerant flow circuit

R.004 General Installation View

R.005 Glycol Tank and Ice Rink

R.006 Low Pressure Vessel

2. INSTALL ELECTRICAL SYSTEM

All Competitors will supplied with all necessary equipment and materials to complete the installation of the refrigeration system in accordance with test project drawings and WorldSkills International Standard for Refrigeration and Air Conditioning.

All cabling to be installed in double insulated, flexible cable or single insulated cable protected by conduit, no single insulated cable is to be left without additional protection.
All temperature probe cables to be protected by conduit.

Refer to the following project drawings to assist to complete this task

R.007 Electrical Control Panel

R.008 Electrical Control Diagram

R.009 Electrical Power Diagram

R.010 Electrical Terminal Connections

3. PRESSURE TEST SYSTEM

Carry out a staged pressure test of the primary refrigeration system (R134a) to a value of 9.5 bar gauge (950kpa). The pressure test point should not drop 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, the Competitor can continue to fix the leak and achieve the pressure test, however the full mark for Pressure Test will be lost. The pressure test will be monitored remotely via a data logging process to ensure all Competitors achieve the required pressure and standing time.

To be filled in by COMPETITORS

PRESSURE TEST ATTEMPT #1

Starting test pressure: _____ ☐ kPa ☐ psi

Starting Time: _____

Test pressure after standing time: _____ ☐ kPa ☐ psi

Finishing Time: _____

PRESSURE TEST ATTEMPT #2

Starting test pressure: _____ ☐ kPa ☐ psi

Starting Time: _____

Test pressure after standing time: _____ ☐ kPa ☐ psi

Finishing Time: _____

4. EVACUATION

Evacuate the primary refrigeration system (R134a) in accordance with manufacturer's instructions and WorldSkills standards using the **Deep Vacuum Method** to hold a vacuum of at least 1000 microns (130Pa absolute) of mercury. The evacuation point should not rise to a value greater than 1000 microns in the Ten (10) minutes after the vacuum pump is isolated from the system under test.

To be filled in by EXPERTS ONLY

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: _____

Comments:

Refrigeration Evacuation Test	Expert 1 Initials & Country: Expert 2 Initials & Country: Expert 3 Initials & Country:

5. CHARGING WITH REFRIGERANT – PRIMARY CIRCUIT

Charge the primary refrigeration system (R134a) with the required weight of refrigerant to ensure operation according to specification above, and in accordance with acceptable trade and environmental practices.

To be filled in by EXPERTS ONLY

Bottle weight prior to charging: _____ ☐ kg ☐ lb

Bottle weight at completion of charging: _____ ☐ kg ☐ lb

Comments:

6. CHARGING WITH REFRIGERANT – SECONDARY CIRCUIT

Charge the secondary refrigeration system (propylene glycol) with the required quantity of glycol and water to ensure operation according to specification above, and in accordance with acceptable trade and environmental practices.

To be filled in by EXPERTS ONLY

Bottle volume prior to charging: _____ ☐ L ☐ fl oz

Bottle volume at completion of charging: _____ ☐ L ☐ fl oz

Comments:

7. ELECTRICAL TESTING

Under the supervision of an Expert, perform all necessary safety checks to ensure the Test Project is safe to energize.

PLEASE FILL IN THE EXPERT CHECK POINT SHEET BELOW BEFORE PROCEEDING ANY FURTHER

To be filled in by EXPERTS ONLY

Competitor Name:

Competitor Country:

All wiring inspected by Expert prior to energizing: ☐ Yes

Electrical safety checks performed prior to energizing: ☐ Yes

Comments:

Refrigeration System Electrical Test	Expert 1 Initials & Country: Expert 2 Initials & Country: Expert 3 Initials & Country:

8. COMMISSION THE SYSTEM

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 as close to operating temperatures as possible. Please indicate units by checking appropriate boxes.

Ambient Temperature: _____ □ Celsius □ Fahrenheit

Refrigerant Type: _____

Mass of Refrigerant Charge: _____ □ grams □ pounds

Suction Pressure: _____ □ kPa □ psi

Discharge Pressure: _____ □ kPa □ psi

Condenser Subcooling: _____ □ Kelvin □ Fahrenheit Degrees

Total System Superheat: _____ □ Kelvin □ Fahrenheit Degrees

LP Control Cut In: _____ □ kPa □ psi

LP Control Cut Out: _____ □ kPa □ psi

HP Control Cut Out: _____ □ kPa □ psi

HP Control Cut In: _____ □ kPa □ psi

Capacity regulator setting: _____ □ Celsius □ Fahrenheit

Glycol supply to ice rink temp: _____ □ Celcius □ Fahrenheit

Glycol return from ice rink temp: _____ □ Celsius □ Fahrenheit

Condensing Unit Operating Current: _____ □ Amps

Glycol Pump Operating Current: _____ □ Amps

COMPETITION DETAILS - MODULE C

AIR CONDITIONING SYSTEM FAULT FIND, REPAIR & COMMISSIONING

MAXIMUM TIME ALLOWED - 4 HOURS **37.5 MARKS**

SCOPE

Competitors will be provided with an air conditioning system that has been leak tested and verified to have no leaks, pressure testing of the system is not required at any point in time. Competitors will be required to identify 1x electrical fault and 1x refrigeration system fault on the supplied air conditioning systems, once faults have been identified the Competitors will be required to repair the faults including full refrigerant recovery and recharging of refrigerant charge to manufacturer's specifications. Competitors will then be required to commission the system and plot operating conditions on a psychometric chart.

TIMING

Competitors are all to complete this module on C4 at the same time

ASSESSMENT

Competitors will be assessed as per technical description with particular weighting on the fault finding and commissioning of the project.

DRAWINGS

R.011 Cradle for AC Unit

R.012 Psychrometric chart (SI units)

R.013 Psychrometric chart (IP units)

1. FAULT FINDING

All Competitors are required to identify 1 x electrical fault and 1 x refrigeration system fault with the operation of the unit, the root cause must be found and repaired. Once the fault is identified Competitors are to fill in this sheet of paper identifying what they believe to be the fault with the equipment. An Expert then needs to sign this sheet of paper.

All fault finding MUST be done with all relevant safety rules adhered to.

Once faults are found and recorded the Competitor is free to continue by running the unit and progressing to the next stage of the Module.

ELECTRICAL SYSTEM FAULT

Please write down what the fault with the equipment is and any supporting information that indicates what the fault was.

_____

_____

_____

Please indicate what repairs need to be done to the system to return it to normal operation

_____

_____

_____

REFRIGERATION SYSTEM FAULT

Please write down what the fault with the equipment is and any supporting information that indicates what the fault was.

_____

_____

_____

Please indicate what repairs need to be done to the system to return it to normal operation

_____

_____

_____

2. REPAIR SYSTEM

All Competitors are required to repair the faults they have identified on the unit, refrigerant must be removed from the system to repair the refrigeration fault. All necessary materials will be provided to repair the equipment and return it to an operating state

All repairs MUST be done with all relevant safety rules adhered to.

3. RECLAIM SYSTEM

All Competitors are required to repair the fault they have identified on the unit, the refrigerant will need to be removed from the system to complete the repair then the system pressure tested, evacuated and recharged with refrigerant. All necessary materials will be provided to repair the equipment and return it to an operating state.

All repairs MUST be done with all relevant safety rules adhered to.

To be filled in by EXPERTS ONLY

Reclaim System

Reclaim bottle weight prior to reclaim: _____ ☐ kg ☐ lb

Reclaim bottle weight at completion of reclaim:_____ ☐ kg ☐ lb

Comments:

4. EVACUATION

Evacuate the refrigeration system in accordance with manufacturer's instructions and WorldSkills standards using the **Deep Vacuum Method** to hold a vacuum of at least 1000 microns (130Pa absolute) of mercury. The evacuation point should not rise to a value greater than 1000 microns in the Ten (10) minutes after the vacuum pump is isolated from the system under test.

To be filled in by EXPERTS ONLY

Evacuation Test

Starting evacuation level: _____ ☐ microns

Starting Time: _____

Evacuation level after standing time: _____ ☐ microns

Finishing Time: _____

Comments:

Air Conditioning System Evacuation	Expert 1 Initials & Country: Expert 2 Initials & Country: Expert 3 Initials & Country:

5. CHARGING WITH REFRIGERANT

Charge the refrigeration system with the required weight of refrigerant to ensure operation according to specification above, and in accordance with acceptable trade and environmental practices.

To be filled in by EXPERTS ONLY

Refrigerant Charging

Bottle weight prior to charging: _____ ☐ kg ☐ lb

Bottle weight at completion of charging: _____ ☐ kg ☐ lb

Comments:

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

Return Air Wet Bulb Temperature: _____ □ Celsius □ Fahrenheit

Supply Air Dry Bulb Temperature: _____ □ Celsius □ Fahrenheit

Supply Air Wet Bulb Temperature: _____ □ Celsius □ Fahrenheit

Air Velocity of indoor unit: _____ □ m/sec □ ft/sec

Air Volume of indoor unit: _____ □ m3/sec □ cfm

Indoor Fan Speed: □ High □ Medium □ Low

Mode of Operation: □ Cooling □ Heating

Refrigerant Type: _____

Mass of Refrigerant Charge: _____ □ grams □ pounds

Suction Pressure: _____ □ kPa □ psi

Total System Superheat: _____ □ Kelvin □ Fahrenheit Degrees

Compressor Operating Current: _____ □ Amps

Indoor Fan Operating Current: _____ □ Amps

7. COOLING PROCESS

Plot the supply and return air conditions as specified in your commissioning report on the psychrometric chart supplied. Join the supply and return conditions with a line as per below example.