

TEST PROJECT REFRIGERATION AND AIR CONDITIONING

WSC2017_TP38_actual



TEST PROJECT MODULES

There are Three (3) Modules to complete in the 21 hour competition.

A) Component Fabrication	13.5 Marks Time Allowed 3.0 Hrs
B) Refrigeration System Installation and Commissioning	50 Marks Time Allowed 14.0 Hrs
C) Air Conditioning System Fault Find, Repair and Commissioning	36.5 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 This document will be superseded by Section 4 prior to the competition.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 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 is 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
- All Electrical work involving live testing will require wearing of approved gloves

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 AND BRAZING

MAXIMUM TIME ALLOWED - 3 HOURS

13.5 MARKS

SCOPE

The Competitors are required to fabricate a copper tubing part of the refrigerant circuit that will form the hot gas side heat exchanger; this coil will be incorporated into the design of the system at a later stage. The coil is constructed according to the drawing R.001 and R.002. This entire will be mounted on the working cradle (R.003) and sit also in the bottom of a tank to heat up the water with the potential of the hot gas temperature being installed in Module B.

TIMING

Competitors are to all complete the copper tubing construction 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 Construction part for hot gas side heat exchanger

R.002 Hot gas heat exchanger

R.003 Working cradle

COMPONENTS

Components to be installed are shown in drawing R.001

COMPETITION DETAILS - MODULE B

REFRIGERATION SYSTEM INSTALLATION AND COMMISSIONING

MAXIMUM TIME ALLOWED - 14 HOURS

50.0 MARKS

SCOPE

Competitors are to install a refrigeration system to refrigerate a small scale ice rink and use the hot gas side to heat up water for heat pump application. This system shows the potential of a refrigerant circuit to cool down water on one hand and heat up water for using it for hand washing for example.

The Competitors are required to use the supplied components along with the coil fabricated in Module A to form a refrigeration system for cooling down water to form ice and heat up water with the hot gas side. If the hot water reaches a fixed temperature the system has to switch with the solenoid valves direct to the condenser. A capacity control 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 C1, C2 and C3. 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.001 Construction part for hot gas side heat exchanger

R.002 Hot gas heat exchanger

R.003 Working cradle

R.004 Refrigerant flow diagram

R.005 Ice rink coil

Electrical drawings located in electrical box

COMPONENTS

Components to be installed will include the following;

- Compressor (Copeland RRT10K1E-PFZ959)r
- Condenser Coil assembly (Copeland 566-1167-01)
- Liquid Receiver (Copeland 577-0315-05)
- Filter Drier (Emerson Climate EK-0525))
- Sight Glass (Emerson Climate HMI-1TT2)
- Thermostatic Expansion Valve (Sporlan)
- Hot gas regulator (Danfoss KVC 12)
- Suction Accumulator (Alltemp)
- Solenoid Valves (Sporlan)
- Check Valve (Danfoss)
- Service Valves (NDL)
- Pressure Relief Valves (Superior)
- High and Low Pressure Control (Ranco)
- Electrical switchboard
- Electronic Temperature Controls (Johnson Controls (A421ABC-02C)
for cold water and hot water

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

- 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 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
- High Pressure cut in the system when the Condensing temperature reaches 45 °C
- Temperature controller cut out at -15 °C
- Temperature controller cut in at -10 °C
- Temperature controller cut out at 46 °C to switch the solenoid valves & cut in at 35 °C to start heating water again

SYSTEM OPERATION

- 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 supply with all necessary equipment and materials to complete the installation of the refrigeration system in accordance with test project drawings and World Skills International Standard for Refrigeration and Air Conditioning.

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

R.001 Construction part for hot gas side heat exchanger

R.002 Hot gas heat exchanger

R.003 Working cradle

R.004 Refrigerant flow diagram

R.005 Ice rink coil

2. INSTALL ELECTRICAL 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 Standard for Refrigeration and Air Conditioning.

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

Electrical drawings located in electrical box

3. PRESSURE TEST SYSTEM

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

Pressure test point should be: 55°C

To be filled in by COMPETITORS under supervision by an Expert

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: _____

Refrigeration Pressure Test	Expert 1 Initials and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

4. EVACUATION

Evacuate the primary refrigeration system (R134a) in accordance with manufacturer's instructions and World Skills standards using the **Deep Vacuum Method** to hold a vacuum of at least 2000 microns (260 Pa (2.6 mbar) absolute) of mercury. The evacuation point should not rise to a value greater than 500 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 and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

5. CHARGING WITH REFRIGERANT

Charge the 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 ☐ b

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

Comments:

6. 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 and Country: Expert 2 Initials and Country: Expert 3 Initials and Country:

7. 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

Compressor Operating Current: _____ ☐ Amps

COMPETITION DETAILS - MODULE C

AIR CONDITIONING SYSTEM FAULT FIND, REPAIR, AND COMMISSIONING

36.5 MARKS

ELECTRICAL FAULT FINDING AND REPAIR

MAXIMUM TIME IS 1.5 HOURS

Each Competitor will perform a capacitance test on the compressor capacitor and record the microfarad reading and identify the compressor windings and record the values for the first 15 minutes.

1. At the end of the 15 minutes, the Competitor will begin the electrical fault finding and repair.
2. Once the fault is identified and repaired, the competitor will run the unit to insure the proper electrical operations.
3. Once the unit operates, the competitor will turn the system off, unplug the system and begin recovery.

Capacitor reading	Result:	Mfd
Compressor readings	Run winding: Ω	
	Start winding:	Ω

MECHANICAL REPAIR

Maximum time is 2.5 hours

Start Time:	Expert:	Competitor:
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1. The Competitor and expert will record the **START TIME** of Mechanical Repair.
2. Begin recovery, and record mass removed.
3. Once recovery is complete, remove the damaged section of the tubing, remove and reuse the existing flare nut.
4. Fabricate new copper to repair the damaged area as per the drawing.
5. Once the part is fabricated, present it to the experts for grading of the flare and swage.
6. Once repaired, pressure test with nitrogen to 50°C and check repaired area with soap solution for leaks.
7. If no leaks, remove nitrogen and begin evacuation.
8. System must hold 2500 microns for 10 minutes.
9. Charge the system to manufacture specifications
10. Commission the system.

To be filled in by COMPETITOR

Reclaim System, Record amount removed.

Reclaim bottle weight prior to reclaim: _____ kg b

Reclaim bottle weight at completion of reclaim: _____ kg b

Comments:

2. EVACUATION

Evacuate the system in accordance with manufacturer's instructions and World Skills standards using the **Deep Vacuum Method** to hold a vacuum of at least 2000 microns (260 Pa absolute) of mercury. The evacuation point should not rise to a value greater than 500 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: _____

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

3. 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 COMPETITOR

Refrigerant Charging

Bottle weight prior to charging: _____ ☐ kg ☐ b

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

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

Refrigerant Type: _____

Mass of Refrigerant Charge: _____ ☐ grams ☐ pounds

Suction Pressure: _____ ☐ kPa ☐ psi

Total System Superheat: _____ ☐ Kelvin ☐ Fahrenheit Degrees

Compressor Operating Current: _____ ☐ Amps