

# NATIONAL SKILL COMPETITION MANUAL

## REFRIGERATION, AIR CONDITIONING & HEAT PUMP SYSTEMS

### QUALITY IN EVERYTHING WE DO

The aim of this manual is to advise and guide stakeholders in preparing for all stages of the refrigeration air conditioning and heat pumps national skill competition.

By working through this manual, alongside the 'WSUK Preparation Toolkit' found on line, you can ensure you are competition ready.

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## OVERVIEW

Refrigeration and air conditioning is closely associated with other parts of the construction and transportation industries at all stages and is equally affected by rapid change in these sectors, including growing environmental trends, and legislation.

There is a direct relationship between the nature and quality of the product and service required and the resulting cost and price; therefore, this branch of engineering covers a wide range of products and services.

It is also essential for the refrigeration and air conditioning technician to meet high quality and constantly improving standards of service to comply with the requirements of a greener environment, the customer expectations whilst maintaining growth for their business.

This guide will provide you with a clear path to follow from initial registration to the national finals and beyond.

## CAREER PATHWAY

The RACHP technician works on commercial, residential, public, and industrial projects, including transportation and storage applications.

The refrigeration and air conditioning technician generally works inside domestic, commercial, or public buildings during and after construction and production, and on projects of all sizes and types.

Workers will plan and design, install, test, commission, report, maintain, fault find, and repair systems to a high standard. Quality throughout every aspect of their work i.e. organization and self-management, communication and interpersonal skills, problem solving, flexibility and a deep body of technical knowledge are the universal attributes of the outstanding RACHP practitioner.

Whether the refrigeration and air conditioning technician are working alone or in a team, the individual takes on a high level of personal responsibility and autonomy.

From ensuring a safe and reliable installation and maintenance service, in accordance with relevant legislation / standards, through to diagnosing malfunctions, upgrading and commissioning, and fault finding and correction, the skills of concentration, precision, accuracy, and attention to quality and detail at every step in the process are crucial.

The cold chain plays a significant role in modern global trade in all food commodities, and skilled RACHP technicians are crucial in this connection, as well as in supplying human comfort at home and in buildings. Reducing environmental impact by using environmentally friendly refrigerants (low GWP-refrigerants), minimizing leakage, and reducing energy consumption.

Minimizing heat load and improving efficiency is an important part of this occupation's contribution to a sustainable future on Earth, by reducing the consumption of fossil fuels like coal, gas and oil, in favour of electricity generation.

## Qualifications

The only legislative qualification currently required in the RACHP industry is F-Gas.

However, whilst we would like to think this qualification ensures consistent quality performance by an operative, sadly it does not. Therefore, a recognised apprenticeship that includes a term of study along with practical skills training is required. Flame brazing is the predominant method of joining refrigerant pipe and components, as such training on an annual basis should be undertaken and recorded in your employers records.

The Institute of Refrigeration (IoR) is a very useful resource for finding out where you can learn to be an RACHP technician. [www.ior.org.uk](http://www.ior.org.uk)

The RACHP apprenticeship standard is also available via the institute for apprenticeship's web site. [www.instituteforapprenticeships.org/](http://www.instituteforapprenticeships.org/)

## Working hours and Salary

You will normally work from 8am to 4pm Monday to Friday; however, the opportunity to work overtime in the evenings and weekends is very likely to be available.

The working environment may vary depending on the job. For the Installation of a system, you may be required to work on a building site and will be expected to wear safety clothing for the duration of the installation works. Whereas for the commissioning and maintenance of a system you will most likely be working in an indoor plantroom environment.

The average salary for a technician is around £20,000 (starter) to £35,000 (experienced): (IoR,2021).

Apprentices must be paid the national minimum wage (although some employers may pay more).

You can discover more information by going to the national careers service and searching for refrigeration

<https://nationalcareers.service.gov.uk/job-profiles/refrigeration-and-air-conditioning-installer>

There are several progression routes after apprenticeship.

- Installation technician / manager
- Service and Maintenance technician / manager
- Contract engineer / manager
- Project engineer / manager
- Commissioning engineer

Many qualified RACHP technicians go onto own a business and after much experience work as consultants.

## COMPETITION REGISTRATION

For helpful information and resources, including registration, competition rules, and entry criteria visit: <https://www.worldskillsuk.org/competitions/> and at [www.coriolisinternational.co.uk](http://www.coriolisinternational.co.uk) .

Registration opens around the middle of February every year to all candidates wishing to participate in the annual competition, lead up events and qualifiers. Eligibility depends on being enrolled on an RACHP course and have experience with handling F-Gas refrigerants and flame brazing / fabrication of copper materials.

This process will be streamlined by involving Colleges and Training Providers to make recommendation for which students they believe have both the practical ability and knowledge & understanding to progress throughout the competition.

It is advised that all suitable candidates who participate in the Passive stages (local college tests) must be registered before the registration closing date.

Prior to the registration opening date, the colleges and training providers will be provided with links taking them to a variety of online forms to obtain agreement and commitment from both the candidate and the candidates employer to ensure that, if successful, the candidate will be available and willing to progress through each stage to the final if successful. Note, attendance at the final may require the candidate to cover the cost of hotel accommodation and meals for the duration of the 3 day competition.

Once initial registration is complete, the colleges and training providers will then be able to issue the stage 2 entry stage test to all participating candidates to complete.

Note:

All competitors registered will receive notification from the competition organiser and /or Worldskills UK by email that they need to complete registration by agreeing to the Terms and Conditions.

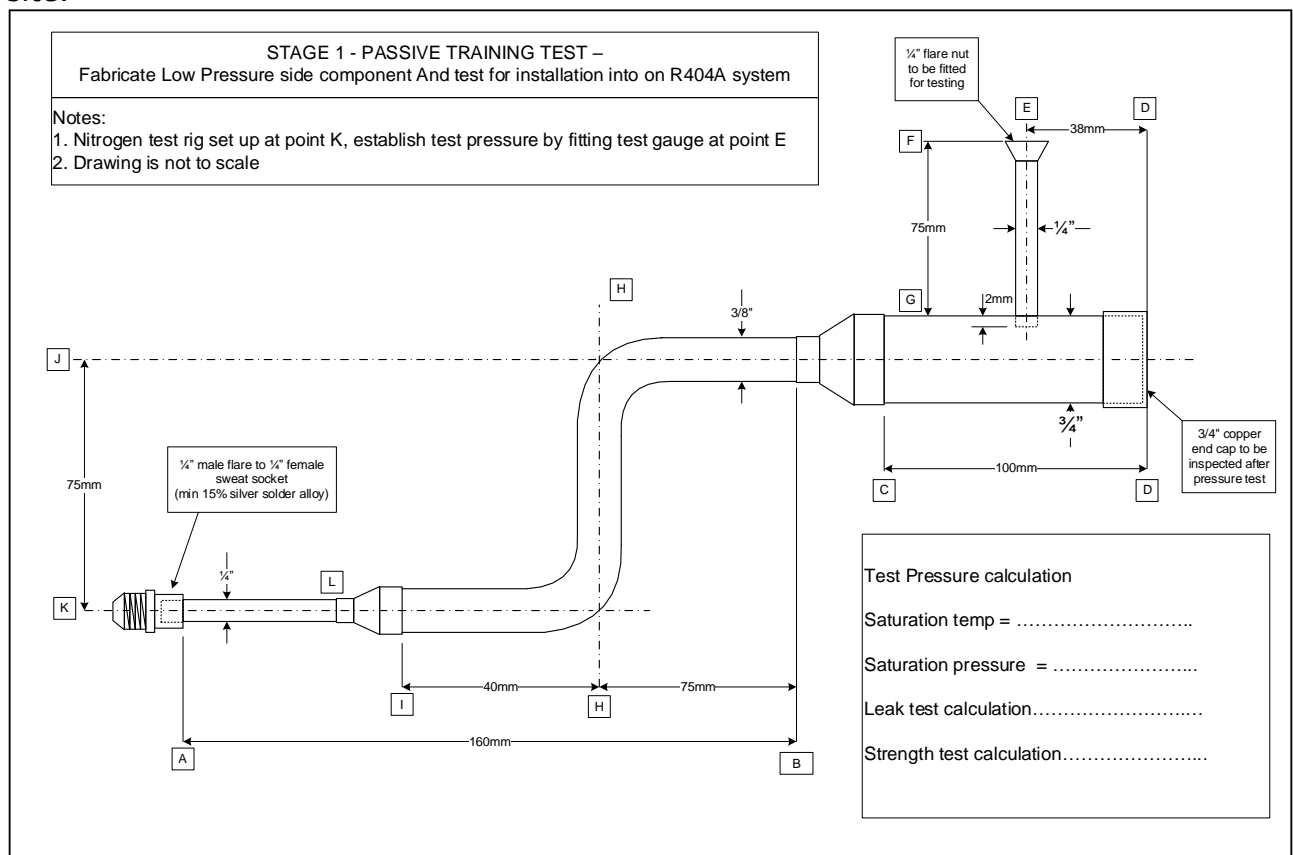
This is mandatory and part of the GDPR and Data Protection rules. If the competitor does not agree, then registration is not completed as their details cannot be shared with any third party and or the competition organising partner.

## PASSIVE COMPETITION

### Pre-competition Activity – entry stage 1

Before or during pre-competition registration, competitors should try to familiarise themselves with competition style activities, for example you could ask your tutor to set up a lesson that covers 'stage 1 entry stage test' and mark it yourself, alternatively carry out this test in your company workshop.

The diagram below is an extract from the stage 1 test, the full test including tools and materials list, standards and a marking scheme is available on the competition web site.



#### Materials required:

Copper tube: 150mm x 3/4"OD, 250mm x 3/8"OD, 150mm x 1/4"OD

1 x 1/4" SAE Flare nut,

1 x 3/4" to 3/8" socket reducer, 1 x 3/8" to 1/4" socket reducer, 1 x 3/4" cap end,

1 x 1/4" male flare to 1/4" female sweat socket

Flame brazing gases (MAPP gas, Oxygen & Acetylene/Propane gas or alternative)

Oxygen Free Nitrogen

1 x stick 40% Silver Solder alloy and flux to suit.

1 x stick Cupro (15% Silver) or similar brazing alloy

The student self-marks the finished work according to the marking scheme provided, with the tutor overseeing the scoring and taking ownership of the assessment methodology.

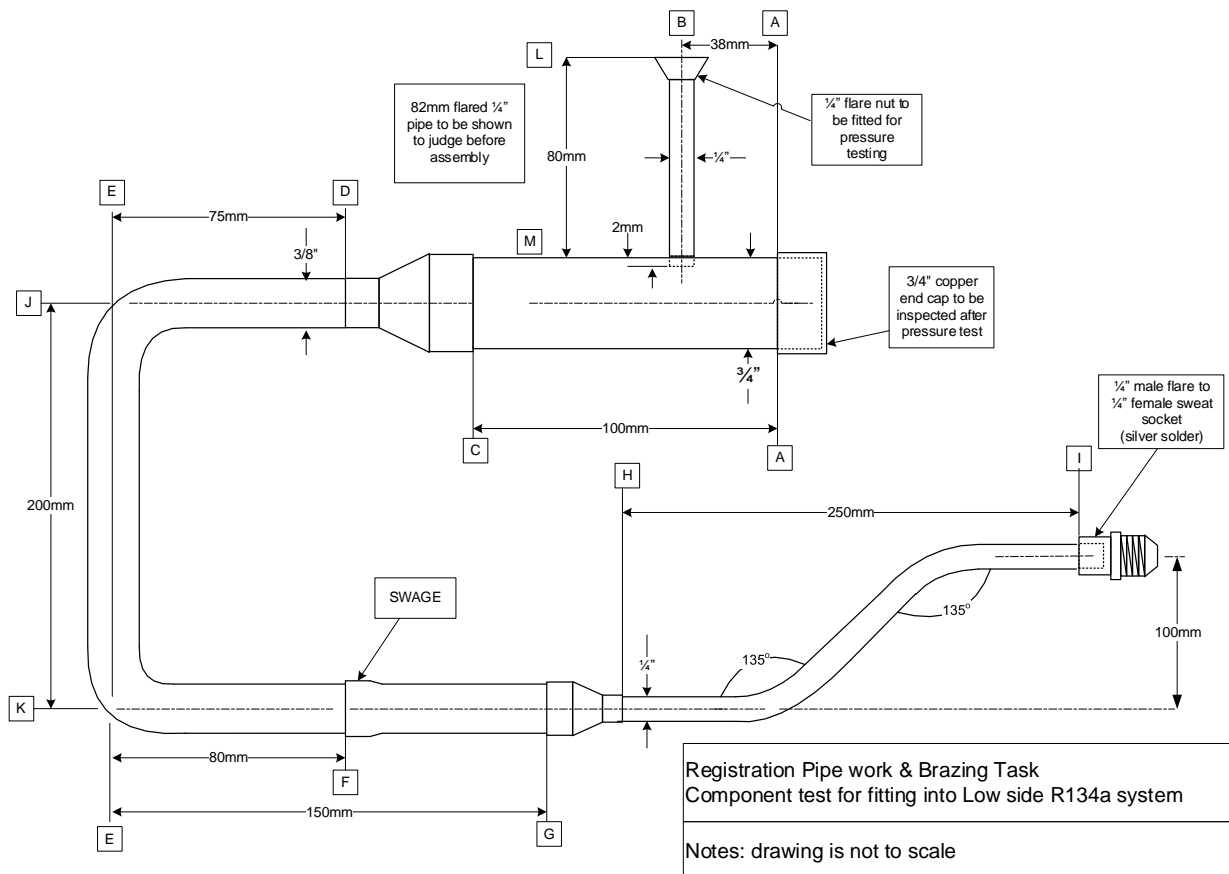
The student can practice this test or variations (less time or different dimensions) as many times as they wish to gain experience.

## Passive Competition – stage 2

Once you have registered, we recommend you carry out a staged process of training that includes:

- ✓ Pipework fabrication
- ✓ Pressure testing
- ✓ Evacuation
- ✓ Refrigerant handling – charging and recovery

We have created a 'stage 2 Passive test' to help you prepare for the regional heat. This consists of another fabrication task which tests your ability to make an offset bend and your knowledge of pressure testing. You can also practice evacuating the finished job. A larger marking scheme is provided to help you understand the criteria.



### Materials required:

200mm x 3/4" OD copper tube, 500mm x 3/8" OD copper tube, 400mm x 1/4" OD copper tube,  
 1 x 1/4" SAE flare nuts, 1 x 3/4" to 3/8" socket reducer, 1 x 3/8" to 1/4" socket reducer,  
 1 x 3/4" cap end, 1 x union 1/4" male flare to OD sweat 1/4" female socket  
 1 x stick Silver (40%) alloy rod and flux to suit.  
 1 x stick Cuprol (15% silver) or similar brazing rod  
 Oxygen gas, Acetylene gas, Oxygen Free Nitrogen

## NATIONAL QUALIFYING HEATS

Regional qualifying heats will be held at regional training centres as follows unless a superheat is arranged at an exhibition centre:

Date	Venue	Address
12 April	Practical Refrigeration Training Centre	Plumbe Street, Burnley. BB11 3AW
19 April	Bath college – Radstock campus	Wells Road, Westfield, Radstock. BA3 3RW
20 April	Glasgow Kelvin college	123 Flemington Street, Glasgow G21 4TD
25 April	City of Portsmouth College	Northarbour Unit 1, Habourgate, Southampton Road, Portsmouth. Hampshire PO6 4BQ

You can enter a minimum of 6 and maximum of 8 competitors into the competition. It is advisable to enter a mix of competitors ages – anyone over 21 will not be eligible to continue after the national finals into WSUK international competitions.

A minimum of 4 and a maximum of 8 highest scoring candidates from all the qualifying heats 'national league table' will be invited to compete at the national final held in November unless a special edition competition is planned at a different time of the year.

The regional qualifying heat event will follow a typical workday as follows.

TIME	ACTIVITY
0800	Arrival sign in
0815 -0830	Safety induction (local risk assessment review) and competition introduction
0830-0900	Familiarisation with tools, materials and equipment
0900-1200	Skill Competition Group 1 Part A, Group 2 Part B
1200-1300	Lunch and work area changeover
1300-1330	Familiarisation with tools, materials and equipment
1330-1630	Skill Competition Group 1 Part B, Group 2 Part A
1630-1730	Marking & Feedback to competitors
1730-1800	Depart

Every competition is assessed by judges according to a marking criterion, and for the RACHP regional qualifying competition it is as follows:



Weighting	Aspect	Criteria	Maximum mark
1	D	PRESSURE TESTING & EVACUATION	14
2	B	REFRIGERANT RECOVERY (emission control)	16
3	E	REFRIGERANT ADDITION (emission control)	16
4	F	COMMISSIONING (efficient operation / set up)	20
5	C	ELECTRICAL WIRING & CONTROL FAULT FINDING	12
6	A	PIPE WORK FABRICATION	22
	<b>Total marks</b>		<b>100</b>

The maximum mark for each criterion may change slightly for each annual cycle. However, it will be the same for each regional event in any annual cycle.

#### Pipe work fabrication task

Competitors are to fabricate a test piece using permanent (brazed) and non-permanent mechanical joints (flared) according to a detailed diagram.

They will be provided with soft copper pipe, additional materials and components will be provided to make a sealed system that will require pressure testing.

They will be expected to maintain a safe working environment and apply a systematic method of work to complete the installation within the timescale specified.

They will have to use various methods of pipe bending and flame brazing of fittings, using both 5% & 40% silver/copper alloy.

A briefing will be provided by judges prior to the competition start.

#### Refrigerant handling task

Competitors are to recover refrigerant from an existing system, pressure test, evacuate, and add refrigerant back into the system.

Competitors will need to complete specific records and demonstrate their actions using the following documents.

- F-Gas record (Refrigerant additions, removals, leak testing)
- Pressure testing certificate (high side and low side)
- Evacuation certificate
- Operational log record

To do well in this task, competitors must not contaminate the refrigerant by adding any non-condensable gases during recovery and charging and must demonstrate best practice to avoid refrigerant emissions to atmosphere.

### Electrical Test and Fault Find task

The electrical fault find test will be carried out on the same system as used for refrigerant handling.

Competitors are to use a multi-meter to test the electrical wiring will not trip the main power supply breaker when the system is powered up.

They will need to demonstrate their actions to the judges during the test.

The functional tests will require testing to ensure no voltage is present prior to testing for earth continuity.

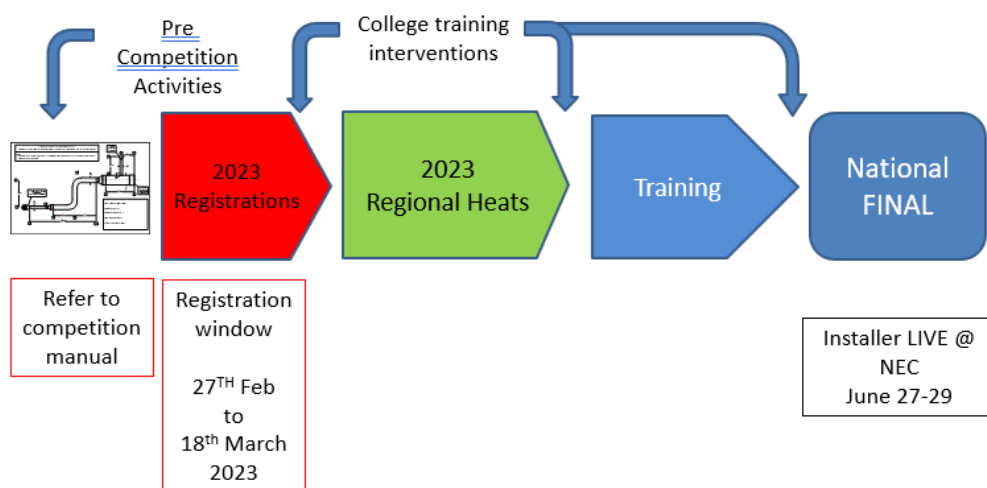
Competitors will be expected to check all terminations and complete a specific electrical test record for

- Earth continuity test
- Neutral continuity test
- Short circuit test

A competition training guide is available from the competition organising partner web site. The guide includes useful hints and tips that judges are looking for and includes the quality of work standards and tolerances connected to the criterion.

The competitors invited to the national final will be invited to a training event that will prepare them for the final and also offered the opportunity to attend a Worldskills UK Boot Camp.

#### The route to National Final



To ensure the integrity and standard of assessment, this will be assessed by industry personnel rather than internal staff at the college or training provider. Verification of the qualifier will be conducted by competition staff.

## TRAINING BOOT CAMP for finalists

There will be a one-day event for the competitors and 2 reserves which will aid the apprentices in preparing for the WorldSkills UK Finals. This training is scheduled to take place in October with final details, locations and dates provided prior to the event.

The training will be provided by industry made up of Worldskills UK, the Competition Organising Partner and Sponsors:

- WorldSkills UK live competition brief – detailing what is expected during the competition and how the event will be managed
- RACHP system principles training – for efficient set up of systems
- Flame brazing training - similar and dissimilar metals
- Details of all WorldSkills UK rules and requirements
- Health and Safety rules and requirements to be followed throughout the duration of the competition

## NATIONAL COMPETITION FINAL

The final is held in the month of November each year. The highest scores above 50% from all regional heats who have complied with WSUK rules, can be invited to the Worldskills UK national skill competition finals.

A recommended Tool List will be updated and available on the competition organiser web site. Hand tools (screwdrivers, wire strippers, spanners etc) are to be brought by competitors, however specialised RAC tools are provided for use in the competition, refer to Appendix A.

- National finalists compete for Gold, Silver & Bronze medals and the RACHP skill UK award.
- Accommodation and meals are covered for all finalists.
- Sponsors provide awards for all competitors.
- Attendees are responsible for travel to and from the final venue.

Competitors are expected to arrive on (C-1) for an induction & familiarisation prior to competition start day (C1).

Competition commences as follows.

Day	Sunday	Monday	Tuesday	Wednesday	Thursday
Reference	C-2	C-1	C1	C2	C3
Activity	Set up	Induction and familiarisation	Competition day 1	Competition day 2	Competition day 3
Who	Competition Organiser (CO)	CO, Assistants, Competitors, Judges	CO, Competitors, Assistants, Judges	CO, Competitors, Assistants, Judges	CO, Competitors, Assistants, Judges

### After the national final

Competitors who are age eligible (under 23 in the year of the final) and scored above the benchmark 60% and who have guaranteed employer support can be invited to Worldskills UK Squad.

A maximum of four Squad members can be invited to progress further with WSUK sponsored training events.

The training can ultimately lead to one person representing the RACHP industry for Team UK at the Worldskills International skill competition in Shanghai 2026.

Further information can be found on the Worldskills UK and Worldskills International web site.

### **INDUSTRY SHOWCASE**

The industry showcase activity gives the competitor a chance to become part of a team event and show off their skills to the public and visitors without the pressure of the competition.

If applicable for the RACHP final, this will commence after the end formal competition ends. You will be part of a team who are given a mini project to deliver.

This is a fun and interactive event that could involve visitors in the form of a "Have a Go" activity and provide the visitors with a hands-on experience of the RACHP industry.

## JUDGES TOP TIPS

### Preparation and Practice

A successful competitor needs to be confident, calm and self-assured when competing. Prepare by practicing your skills and techniques to ensure you get the required standard/results you want without any surprises.

### Time Management

Learn to manage your time effectively when completing tasks by working smart not fast! The tasks have allocated times, so practice working to time and under pressure to perfect your timing. If you run out of time in the competition you will lose marks.

### Planning

Make your own plans for how to complete each task, work methodically and even write it down to help you prepare. No point copying another competitor.

### Organisation

Make sure all stages of a task can be completed by organising all of your equipment and materials for each task.

### Health & Safety

Is everyone's responsibility, make sure you use the appropriate PPE for the task and work safely.

### Clean and Tidy

Keep your working area tidy as you can be more efficient in a tidy work area. Make sure that when you present your work to the judges it is clean and ready for final judging.

### Understanding

Read the task instructions thoroughly and make sure you understand what you need to do. Do not be afraid to ask questions, remember there is only one silly question.....the one you didn't ask!

### Don't Worry

If any part of a task hasn't gone as well as you might have wanted, don't worry or dwell on it, just draw a line under that and get on with the next task. Always focus on the marks you can gain not what you might have lost.

### Enjoy

Reaching the WorldSkills UK National Qualifiers/Regionals or the WorldSkills UK Live National Finals is itself a huge achievement that you should be extremely proud of. Make the most of the WorldSkills UK RACHP skills UK competitions process and enjoy it.

### Technical Top Tips

You can find more training guidance and top tips, within the RACHP skills UK technical guide available on Worldskills UK web site.

## CORE COMPETENCES

### Refrigeration Air Conditioning & Heat Pump Skill Competitions

<b>Skills &amp; Knowledge to be demonstrated</b>	<b>Heat</b>	<b>Final</b>
Work safely (work organisation)	#	#
Follow detailed work plan instructions	#	#
Calculate the area and volume of shapes	#	#
Measure, cut and fabricate materials used in RACHP industry	#	#
Assemble pipe work, insulation and components to prescribed instructions	#	#
Join materials using non-permanent mechanical fixing methods (i.e., flare)	#	#
Join materials using permanent non mechanical methods (i.e., braze, solder, glue)	#	#
Join materials using permanent mechanical fixing methods (e.g., Lokring/Maxipro)		#
Pressure test pipe work and components to BSEN 378 standard	#	#
Evacuation to industry standards	#	#
Test control wiring and basic components for electrical faults	#	#
Interpret simple ladder/connection wiring diagrams for RACHP systems	#	#
Correct use of tools, materials and components used in the RACHP industry	#	#
Completion of commissioning sheets and F-Gas records (communication)	#	#
Refrigerant Recovery, Charging, Leak testing and record completion (F-Gas cat 1)	#	#
Analyse information in order to overcome challenges (problem solve)	#	#
Analyse operation and use test instruments to find faults	#	#
Install control wiring and electrical components		#
Interpret simple ladder/connection wiring diagrams		#
Measure and plot condition of air on a Psychrometric chart		#
Measure and plot condition of refrigerant on a Pressure Enthalpy diagram		#

## TALENT SPOTTING CHECKLIST

This list identifies the ideal personal attributes and requirements for a skills competition participant.

You can use this to identify your most appropriate candidate to enter the competition.

The ideal person will have as many of these attributes as is possible.

<b>Candidate's Name:</b>	<b>Confirm</b>
<b>In January of the competition year, is either working towards or have achieved S/NVQ level 2 or equivalent.</b>	
<b>Has or will have achieved a recognised F-Gas category 1 standard in handling refrigerants before the regional qualifier event.</b>	
<b>Can use specialised tools i.e. vacuum pump, recovery unit, brazing and nitrogen equipment for pressure testing.</b>	
<b>Can use flame brazing equipment i.e. oxygen and propane/acetylene and MAPP gas.</b>	
<b>Is accurate when taking and applying measurements</b>	
<b>Uses RAC theory of basic system operation to its full potential</b>	
<b>Is motivated to do well at college</b>	
<b>Is motivated to do well in the workplace</b>	
<b>Can adapt to a different working environment</b>	
<b>Keeps a cool head when under pressure to solve a problem</b>	
<b>Thinks before acting</b>	
<b>Is motivated to complete work within tight time schedules</b>	
<b>Maintains a quality finish in the work they produce</b>	
<b>Has good communication and interpersonal skills</b>	
<b>Shows a high level of capability and flexibility</b>	
<b>Possesses mental and physical stamina</b>	
<b>Confident, yet not overconfident</b>	
<b>Has a driving license and use of a vehicle</b>	
<b>Has supportive employers</b>	
<b>Is comfortable with using public transportation, i.e. rail, bus</b>	

## **COMPETITION RULES & Code of Conduct** in addition to Worldskills UK rules

To ensure everyone is fully aware of the expected standards, practices and rules, we ask everyone to sign up to a code of conduct. This aims to ensure fairness, transparency and equality and thus is to be observed at competitions organised by the competition organising partner (COP) and its associates.

- \* Exemplary and professional conduct at all times, this includes work practices, communication with judges, skills team and other competitors.
- \* Personal appearance and conduct are as equally as important during competition time as they are when not at the competition venue, we expect all participants of the skills competition to behave in accordance with rule 1 at all times.
- \* The design and specification of all competition tasks are the property of the COP and unauthorised copy, or use is not permitted unless agreed in advance by the COP competition management team.
- \* The COP and its sponsors / supporters reserve the right to prohibit unauthorised use of promotional material within the competition area.
- \* Communication/coaching the competitor during the competition is not allowed.
- \* Hotel accommodation is for competitor sole use only.

### **Skill Specific Competition Rules –**

1. Competitors/judges conduct will be always exemplary and not bring the competition organising partner into disrepute.
2. Competitors will always be required to wear the provided official identification badge when outside of the competition stand.
3. Competitors must be prepared to cover their own travel expenses to and from the competition and may be required to pay for hotel accommodation during the final.
4. Competitors will be expected to arrive on each competition day in a fit condition ready to compete and will attend activities to which they are assigned on time.
5. Competitors are liable for any damages or breakages that may occur during the competition (including any applicable overnight stays).
6. Where competitors are accommodated for the attendance of a competition no other persons (except hotel / Skills staff) will be allowed to enter these rooms and that high standards of occupancy are always expected from competitors.
7. The use of alcohol and non-prescribed / drugs is not allowed at any time during a competition event, any competitor who is believed to be under the influence of alcohol or drugs will be expelled from the competition.



8. Competitors shall observe all health and safety rules and requirements including rules surrounding Covid 19. In the event of a fire drill, competitors should follow the appropriate emergency evacuation procedures of the competition and accommodation venues.
9. Sickness or any accidents should be brought to the attention of the COP.
10. Competitors are responsible for bringing and wearing the appropriate Personal Protective Equipment (PPE) to the competition venue and must always wear PPE when in competition.
11. Local venue rules will apply for smoking and vaping. No vaping on competition stand.
12. Mobile telephones or cameras cannot be used during the competition or in the competition area unless the COP gives permission (this is usually at the end).
13. Competitors may only leave the competition area for designated meal breaks/rest breaks, any person wishing to leave the stand at any other time should obtain permission from the COP events team.
14. Meal/rest breaks should be taken away from the competition area.
15. Drawings and test information shall not be removed from the competition area unless authorised by the chief Judge.
16. Competitors are prohibited from using pre-drawn plans / templates / photos within the competition area.
17. It is not permitted to borrow tools or test equipment from other competitors, unless authorised by a judge.
18. The competitor must ask for a judge to witness specific test procedures i.e. pressure test, evacuation rise test, electrical test, charging and recovery.
19. All working areas must be left clean and tidy at the end of each day of competition.
20. Competitors should not get into conversation with members of the public or persons not involved with the competition, this includes supporting families and college tutors during competition time, unless authorised by COP staff.
21. During competition hours, competitors are not allowed to discuss the drawings or competition tasks with anyone other than the competition judges.
22. The lead judge will provide arbitration in the event of issues arising.
23. Data protection consent will be required at time of registration. Failure to accept the terms and conditions will result in registration being denied.

## CONTACTS

For Worldskills UK visit the web site



RACHP skills UK competition management



For RACHP skills UK competition technical manager

Mark Forsyth

[markf@coriolisinternational.co.uk](mailto:markf@coriolisinternational.co.uk)

For Publisher/Editor of skills competition

Installer LIVE

For Fujitsu air conditioning

Martyn Ives

Distribution Sales / Technical Services Director

[Martyn.Ives@fgac.fujitsu-general.com](mailto:Martyn.Ives@fgac.fujitsu-general.com)

**APPENDIX A – TOOL LIST**

The tool list is subject to change as and when sponsors update their supply.

QTY	General Hand Tools	Model/size/part no	Supplier / Sponsor	Heat	Final
1	Full set of screwdrivers flat and cross head		Competitor	#	#
1	Insulated standard pliers - long nosed and short		Competitor	#	#
1	Side cutters for cable		Competitor	#	#
1	Wire stripper / crimper		Competitor	#	#
1	Hacksaw	300mm/12" 24tpi	Competitor	#	#
1	Jokari wire stripper 8mm to 28mm	10270	Competitor		#
2	Adjustable spanners up to 3/4 inch pipe nut	5/8", 3/4", 1/2", 1/4"	Competitor	#	#
1	Refrigeration service ratchet wrench	Mastercool 70081	Competitor	#	#
1	Tape measure	3mtr	Competitor	#	#
1	Adjustable Combination Set square	300mm	Competitor	#	#
1	Pen and Pencil (plus spare)		Competitor	#	#
1	Fixed rule	300mm	Competitor	#	#
1	Spirit Level	150mm	Competitor		#
1	High Speed Steel drill bits	1mm to 10mm (3/8 ")	Competitor	#	#
1	Hammer		Competitor	#	#
1	Mesh cleaning pad for pipework		Competitor	#	#
1	Battery drill / screwdriver 9v or 14v	12mm chuck	Competitor		#
1	Stanley tools hobby vice or similar	159659	Competitor		#

**Note \*General hand tools to be supplied by competitor/college for all Qualifier Heats and National Final**

QTY	Electrical Equipment and Test Instruments	Model/size/part no	Supplier / Sponsor	Heat	Final
1	Multi meter with digital thermometer & K type sensor	SC440	COP / Fieldpiece	*	#
1	Wireless 4 port Service manifold with micron gauge	SMAN460	COP / Fieldpiece	*	#
1	Anemometer (air vane type)		COP / Fieldpiece	*	#
1	Remote monitoring kit	Joblink kit JL3KH6	COP / Fieldpiece	*	#
1	Dry bulb / Wet Bulb thermometer		COP / Fieldpiece	*	#
1	Digital thermometer		COP / Fieldpiece	*	#
1	Surface temperature probe	K type connector	COP / Fieldpiece	*	#
1	Air temperature sensor probe	K type connector	COP / Fieldpiece	*	#

**Note \*Electrical tools to be supplied by competitor/college for all Qualifier Heats**

QTY	Refrigeration tools & equipment		Supplier	Heat	Final
4	Hoses for service manifold including recovery unit	1/4" SAE,	Competitor	*	#
1	Hose for evacuation	3/8" SAE	Competitor	*	#
1	R410A / R32 brass refrigerant adaptor for charging hose	5/16" SAE to 1/4" SAE	Competitor	*	#
1	Refrigerant cylinder (bottle) adapter to 1/4" hose		COP / Fieldpiece	*	#
1	Copper pipe benders for half hard rigid tube	1/4" , 3/8", 1/2", 5/8"	COP / Diversitech	*	#
1	Copper Pipe Flaring tool / swage kit	1/4" to 5/8"	COP - JAVAC	*	#
1	Rotary copper tube cutters	1/4" to 5/8 "	Competitor	*	#
1	Solenoid magnetic Lifters	10mm & 15mm	Competitor	*	#
1	Vacuum Pump	Robinair 3cfm, 240v	COP / Advanced Eng	*	#
1	Recovery unit for R410A, R32 & R134a, R513A	Promax 240v	COP / Advanced Eng	*	#
1	Electronic leak detector	BOSCH TIF ZX-1 or similar	COP / Fieldpiece	*	#
1	Refrigerant weigh scales (digital)	SRS3	COP / Fieldpiece	*	#

**Note \*Refrigeration tools to be supplied by competitor/college for Heats**

QTY	Gases and special tools & equipment	Model/size/part no	Supplier / Sponsor	Heat	Final
1	Nitrogen hose line ¼" (braded) with valve set to regulator	¼" SAE	COP /	*	#
1	Nitrogen regulator	GA750 (0-50bar)	COP / Javac	*	#
1	Nitrogen cylinder (oxygen free)	10ltr	COP / CLIMALIFE	#	#
1	Nitrogen purge tool	Diversitech DP1	COP / PUMP HOUSE	*	#
1	Refrigerant receiver Cylinder	8kg	COP / CLIMALIFE	*	#
1	Oxyturbo 1000 flame brazing set	OxyTurbo 1000	COP / Advanced Eng	*	#
1	Oxygen 930ml & maxigas 630mlt cylinders		COP / Advanced Eng	*	#
1	Silver Alloy 5% Ag content	Silver-Flo	COP	*	#
1	Flux Powder	Easy-flo	COP	*	#
5	Copper Alloy 0.8%Ag content	Rolot S2	COP / Lawton Tubes	*	#
1	R134a or R513A Virgin refrigerant	10kg	COP / CLIMALIFE	*	#
1	R134a or R513A Refrigerant receiver	13kg	COP / CLIMALIFE	*	#
1	R410A or R32 Refrigerant receiver	10kg	COP / CLIMALIFE	*	#
1	R410A or R32 Virgin refrigerant	5kg	COP / CLIMALIFE	*	#

**Note \*Gases and special tools to be supplied by competitor/college for Heats**

**Refer to competition risk assessment**

QTY	Personal Protective Equipment	Model/size/part no	Supplier / Sponsor		Final
1	Goggles / Safety Glasses (suitable for refrigerant handling)		Competitor		#
1	Tinted Safety Glasses (suitable for flame brazing)		Competitor		#
1	Gloves (suitable for refrigerant handling)		Competitor		#
1	Gloves (suitable for flame brazing)	Soft Suede Gauntlet	Competitor		#
1	Safety footwear		Competitor		#
1	Coveralls (for refrigerant handling & flame brazing)		Competitor		#
1	Dust max (for silver brazing with flux)		Competitor		#