

CONSTRUCTION AND BUILDING TECHNOLOGY

Refrigeration and Air Conditioning



WorldSkills Occupational Standards

WorldSkills Occupational Standards (WSOS)

Occupation description and WSOS

The name of the occupation is

Refrigeration and Air Conditioning

Description of the associated work role(s) or occupation(s)

A refrigeration and air conditioning technician works on commercial, residential, public, and industrial projects, including transportation and storage. 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 and growing standards of service in order to comply with the requirements of the customer and maintain and grow the business. 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 requirements.

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. He or she will plan and design, install, test, commission, report, maintain, fault find, and repair systems to a high standard. Work organization and self-management, communication and interpersonal skills, problem solving, flexibility and a deep body of knowledge are the universal attributes of the outstanding practitioner.

Whether the refrigeration and air conditioning technician is 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 standards, through to diagnosing malfunctions, upgrading and commissioning, and fault finding and correction, the skills of concentration, precision, accuracy, and attention to detail at every step in the process are crucial. Mistakes may be very expensive and damaging, while substandard work will significantly undermine the performance of the building or equipment that it is intended to serve.

The cold chain plays a significant role in modern global trade in all food commodities, and skilled refrigeration and air conditioning technician 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.

General notes on the WSOS

The WSOS specifies the knowledge, understanding, and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSOS).

The skill competition is intended to reflect international best practice as described by the WSOS, and to the extent that it is able to. The Standard is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standard is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards. This is often referred to as the “weighting”. The sum of all the percentage marks is 100. The weightings determine the distribution of marks within the Marking Scheme.

Through the Test Project, the Marking Scheme will assess only those skills that are set out in the Standards Specification. They will reflect the Standards as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme will follow the allocation of marks within the Standards to the extent practically possible. A variation of up to five percent is allowed, provided that this does not distort the weightings assigned by the Standards.

WorldSkills Occupational Standards

Section	Relative importance (%)
1 Work organization and management	10

The individual needs to know and understand:

- The health and safety standards that apply to the RAC industry
- How to recognize and respond to hazardous situations while working in the RAC industry
- The safe personal protection measures while working in the RAC industry
- How to apply manual handling techniques
- How to respond to accidents that occur while working in the RAC industry
- The procedures for electrical safety when working in the RAC industry
- How to apply basic electrical safety measures in the RAC industry
- The methods of working safely with heat producing equipment (heat pumps) in the RAC industry
- How to safely work with refrigerant hot gas heating equipment
- The methods of safely using access equipment
- The methods of working safely in confined spaces
- The purposes, uses, maintenance, and care of all equipment, together with their safety implications
- The purposes, uses, care, and potential risks associated with materials and chemicals
- The first aid requirements and actions required for both minor and major injury
- The use of new technologies as a work aid
- The working time associated with each activity
- The parameters within which work needs to be scheduled
- Principles and their application for good housekeeping within the work environment
- How to apply environmental protection measures within the RAC industry
- The applications of energy sources used in the RAC industry
- The importance of energy conservation when commissioning RAC systems
- The methods of reducing waste, and safe disposal of materials in the RAC industry

The individual shall be able to:

- Produce risk assessments and method statements
 - Apply the respective health and safety legislation for the RAC industry
 - Take responsibility for those working in the RAC industry
 - Identify hazards and dangers to the workforce and members of public where RAC work is carried out
 - Identify and implement methods to control common hazardous substances and prevent accidents or dangerous situations occurring in the RAC industry
 - Plan and perform safe manual handling of heavy and bulky items including mechanical lifting aids
 - Prepare and maintain safe and tidy work areas at all times
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Section	Relative importance (%)
<ul style="list-style-type: none"> • Select and use appropriate personal protective equipment in all RAC activities • Select and use appropriate hand tools to complete RAC tasks safely and efficiently • Apply first aid procedures for dealing with minor and major injuries in the RAC industry and record near misses and accidents at work • Safely use access equipment such as step ladders, extension ladders, and mobile towers • Identify common electrical hazards encountered during RAC activities • Demonstrate safe working practice for working with electrically powered tools • Identify how bottled gases and equipment should be transported in the RAC industry • Identify types of energy sources and uses in RAC • Identify and apply basic operating principles of vapour compression systems • Plan work within time limits to maximize work efficiency and minimize disruption • Restore work areas to appropriate conditions 	
2 Communication and interpersonal skills	5

The individual needs to know and understand:

- The identities and roles of the members of construction teams and the building services industry
- How to use information sources
- How to communicate the technical language associated with RAC to others in the building services industry
- The dynamics of working in teams and collaboration with other related occupations and teams to complete tasks
- The working requirements of other trades either operating in the immediate area or affected by installation works
- The range and purposes of documentation, including text, graphical, paper based, and electronic
- The standards required for routine and exceptional reporting in oral, handwritten, and electronic form
- The nature of the reports provided by measuring equipment, together with their interpretation
- The required standards for health, safety, and environment, customer service and care

Section	Relative importance (%)
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The individual shall be able to:

- Read, interpret, and extract technical data and instructions from manuals and other documentation
- Communicate in the workshop by oral, written, and electronic means, using standard formats with clarity, effectiveness, and efficiency
- Use a standard range of communications technology
- Respond to legislative requirements, customers' needs face to face and indirectly
- Use search methods to obtain specific and non-specific information, specifications, and guidance

3 Design refrigeration and air conditioning systems	10
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The individual needs to know and understand:

- The standard units of measurement used in the RAC industry
- The detailed properties of materials and fluids used in the RAC industry
- Relevant Directives applicable to RAC industry
- The relationships and interactions of energy, heat, and power
- Principles of force and pressure and their application to the RAC industry
- Principles of electricity and control circuits as related to the RAC industry
- The detailed properties of fluids used in the RAC industry
- Refrigeration and heat pump cycles
- Condensate drainage and secondary refrigerant circuits
- The information requirements for the design of a refrigeration or air conditioning systems
- The principles and conventions used in specifications and drawings
- The range of specifications and drawings in use, and their purposes
- The uses and limitations of the generally available drawing tools
- The types and use of electrical cables and devices for different applications

The individual shall be able to:

- Appraise the purposes of the required systems
- Appraise the feasibility of locating systems within designated areas
- Calculate relative densities of refrigerants to air and water
- Apply specialist knowledge of the principal applications and detailed properties of solid materials
- Apply the principal applications and basic properties of fluids used in the RAC industry
- Use the terminology associated with latent, sensible heat and fluid change of state
- Carry out heat energy and power, force, and pressure calculations
- Carry out electrical calculations i.e. ohms law, power consumption, voltage, current, and resistance circuits
- Design efficient refrigeration systems that include a range of heat exchangers and refrigerant types: HFC, HC and those with low or zero ODP and GWP
- Choose components and joining methods that ensure leak-tight installation

Section	Relative importance (%)
<ul style="list-style-type: none"> • Design air conditioning systems that would serve comfort cooling applications and also full building applications • Produce drawings and specifications, using standard conventions and symbols • Estimate cost/budget requirements for equipment and materials • Select required equipment and materials according to given criteria, including price and environmental considerations • Check prices and either order equipment and materials or amend the design of systems to maintain the budget 	
4 Installation and maintenance of refrigeration and air conditioning	30

The individual needs to know and understand:

- Specific health and safety requirements that apply to fitting and fixing, servicing, maintaining, and decommissioning RAC systems
- The working principles and layouts of RAC and heat pump systems
- The procedure for fitting, fixing, and testing materials, equipment, and components in RAC systems
- The service and maintenance procedures for RAC systems, equipment, and components

The individual shall be able to:

- Interpret diagrams, plans, and specifications for piping and electricity routes
- Work safely with hot gas heating equipment in the RAC industry
- Prepare and, if need be, improve the area and surfaces which the installation depends upon
- Itemize the required tools, components, and materials required for installations
- Take and transfer measurements and angles from given drawings to surfaces and piping materials
- Identify, check, and use various types of gases and equipment used for joining materials in the RAC industry
- Safely drain oil and recover refrigerants
- Join similar and dissimilar materials commonly found in refrigeration and air conditioning systems using a range of permanent (brazed and compression/crimped) and accessible (flared) jointing methods (~~brazing~~)
- Fabricate and install mechanical materials and components according to drawings and specifications
- Install electrical materials components and control devices according to drawings and specifications
- Install ancillary components and systems found in refrigeration and air conditioning systems such as condensate drainage, and leak detection systems
- Use tools and equipment to apply pressure to test the strength of refrigeration systems or any part of them (see e.g. ISO 5149.2:2014)

Section	Relative importance (%)
<ul style="list-style-type: none"> • Use tools and equipment to apply pressure to test the tightness of refrigeration systems or any part of them (see e.g. ISO 5149.2:2014) • Use tools and equipment to evacuate moisture and non-condensable gases from inside refrigeration systems, and ensuring that the systems are dry and free of leakage 	
5 Commission refrigeration and air conditioning systems	25

The individual needs to know and understand:

- How to interpret the design parameters of given systems
- Safety standards relating to the handling and application of refrigerants
- Safe procedures for applying electrical supply to RAC systems
- How to set up safety controls and devices to satisfy design requirements
- How to ensure the integrity of RAC systems
- How to ensure efficient operation of a system

The individual shall be able to:

- Charge systems with the correct type and quantity of refrigerant for efficient operation without leaking refrigerant to the environment
- Examine systems for leakage after commissioning, using direct or indirect measuring methods (see e.g. ISO 5149.2:2014)
- Assess refrigeration systems for correct operation
- Assess air conditioning systems for correct operation
- Assess any secondary refrigerants or cooling systems for correct operation
- Assess refrigeration or air conditioning systems' electrical installation for correct operation
- Adjust refrigerant controls and flow devices for optimal system performance
- Adjust electrical and electronic controls for optimal system performance
- Balance air distribution systems
- Measure and record RAC system operating parameters
- Ensure the availability of essential client documentation
- Provide training for client operators
- Demonstrate safe functioning and care of systems to clients
- Hand over systems to clients, while responding to all relevant queries

Section	Relative importance (%)
6 Fault finding refrigeration and air conditioning systems	20

The individual needs to know and understand:

- The electrical standards that apply to the RAC industry
- The inspection and testing requirements of electrically operated RAC services and components
- The procedures for safely diagnosing and rectifying faults in electrically operated RAC services and components
- The layout and features of electrical circuits in RAC systems
- The procedure for safe isolation of the specific systems
- The procedure for carrying out risk assessments prior to investigating RAC systems
- The importance of original design and operational parameters
- The impact of system isolation on client operations

The individual shall be able to:

- Inspect and test electrically operated RAC system components
- Safely diagnose and rectify faults in electrically operated RAC services and components
- Prepare and safeguard areas of work and their surroundings
- Safely isolate electrical systems
- Assess refrigerant systems for integrity and correct operation
- Replace faulty refrigerant system components
- Evaluate and test electrical wiring integrity prior to energizing
- Assess electrical installations for correct operation
- Examine whole systems for leakage using direct and indirect methods, knowing the parts most likely to leak
- Reclaim HFC and HFO refrigerants from systems without leakage to the environment
- Safely purge natural refrigerants, like Ammonia or Carbon Dioxide
- Drain and refill compressor lubricants
- Restore work areas and their surroundings to their prior state
- Explain, advise, and report on findings, actions, and matters requiring further attention

Total	100
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References for industry consultation

WorldSkills is committed to ensuring that the WorldSkills Occupational Standards fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and WorldSkills Occupational Standards on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- ISCO-08: (<http://www.ilo.org/public/english/bureau/stat/isco/isco08/>) ILO 3115
- ESCO: (<https://ec.europa.eu/esco/portal/home>)
- O*NET OnLine (www.onetonline.org/)

This WSOS appears most closely to relate to *Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technician*:

<http://data.europa.eu/esco/occupation/3ce9c89d-6f1a-48b5-942d-386e46e2fd06>

and also to *Heating and Air Conditioning Mechanics and Installers*:

<https://www.onetonline.org/link/summary/49-9021.01>

and *Refrigeration Mechanics and Installers*:

<https://www.onetonline.org/link/summary/49-9021.02>

Adjacent occupations may also be explored through these links.

The following table indicates which organizations were approached and provided valuable feedback for the Description of the Associated Role and WorldSkills Occupational Standards in place for WorldSkills Shanghai 2022.

Organization	Contact name
Toshiba Carrier UK Ltd.	Neil Wooldridge, Technical Director