worldskills

Technical Description

Refrigeration and Air Conditioning

WorldSkills International, by a resolution of the Competitions Committee and in accordance with the Constitution, the Standing Orders, and the Competition Rules, has adopted the following minimum requirements for this skill for the WorldSkills Competition.

The Technical Description consists of the following:

1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

Refrigeration and Air Conditioning

1.1.2 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.

1.1.3 Number of Competitors per team

Refrigeration and Air Conditioning is a single Competitor skill competition.

1.1.4 Age limit of Competitors

The Competitors must not be older than 22 years in the year of the Competition.

1.2 The relevance and significance of this document

This document contains information about the standards required to compete in this skill competition, and the assessment principles, methods, and procedures that govern the competition.

Every Expert and Competitor must know and understand this Technical Description.

In the event of any conflict within the different languages of the Technical Descriptions, the English version takes precedence.

1.3 Associated documents

Since this Technical Description contains only skill-specific information it must be used in association with the following:

- WSI – Code of Ethics and Conduct
- WSI – Competition Rules
- WSI – WorldSkills Occupational Standards framework
- WSI – WorldSkills Assessment Strategy
- WSI online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations
- WorldSkills Standards and Assessment Guide (skill-specific)

Documentation specific to the industry

- WorldSkills Refrigeration and Air Conditioning Competition Standards and Assessment Guide
- ISO 817:2014 Refrigerants - Designation and safety classification
- ISO 5149-1:2014: Refrigerating systems and heat pumps - Safety and environmental requirements Part 1: Definitions, classification, and selection criteria
- ISO 5149-2:2014 Refrigerating systems and heat pumps - Safety and environmental requirements Part 2: Design, construction, testing, marking and documentation
- ISO 5149-3:2014 Refrigerating systems and heat pumps - Safety and environmental requirements Part 3: Installation site
- ISO 5149-4:2014 Refrigerating systems and heat pumps - Safety and environmental requirements Part 4: Operation, maintenance, repair, and recovery
- ISO/DIS 22712:2018 FR Refrigerating systems and heat pumps — Competence of personnel

2 The WorldSkills Occupational Standards (WSOS)

2.1 General notes on the WSOS

The WSOS specifies the knowledge, understanding, skills, and capabilities that underpin international best practice in technical and vocational performance. These are both specific to an occupational role and also transversal. Together they 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, to the extent that it can. 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 and capabilities that are set out in the WorldSkills Occupational Standards. 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, if this does not distort the weightings assigned by the Standards.

2.2 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	

Section		Relative importance (%)
	• 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 • 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	

Section		Relative importance (%)
	• 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	
	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**
	The individual needs to know and understand: • The standard units of measurement used in the RAC industry	

Section		Relative importance (%)
	• 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 • 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	

Section		Relative importance (%)
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 procedure for handling HC, HFC and HFO refrigerants	
	The individual shall be able to: • Interpret diagrams, plans, and specifications to determine appropriate 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) • 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	

Section		Relative importance (%)
	• Use tools and equipment to charge and recover HC, HFC and HFO refrigerants	
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 • Solve problems affecting the safe and effective operation of RAC systems • 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	
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	

Section		Relative importance (%)
	• 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 • Solve problems affecting the safe and effective operation of RAC systems • 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 HC, 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**

3 The Assessment Strategy and Specification

3.1 General guidance

Assessment is governed by the WorldSkills Assessment Strategy. The Strategy establishes the principles and techniques to which WorldSkills assessment and marking must conform.

Expert assessment practice lies at the heart of the WorldSkills Competition. For this reason, it is the subject of continuing professional development and scrutiny. The growth of expertise in assessment will inform the future use and direction of the main assessment instruments used by the WorldSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the WorldSkills Competition falls into two broad types: Measurement and Judgement. For both types of assessment, the use of explicit benchmarks against which to assess each Aspect is essential to guarantee quality.

The Marking Scheme must follow the weightings within the Standards. The Test Project is the assessment vehicle for the skill competition, and therefore also follows the Standards. The CIS enables the timely and accurate recording of marks; its capacity for scrutiny, support, and feedback is continuously expanding.

The Marking Scheme, in outline, will lead the process of Test Project design. After this, the Marking Scheme and Test Project will be designed, developed, and verified through an iterative process, to ensure that both together optimize their relationship with the Standards and the Assessment Strategy. They will be agreed by the Experts and submitted to WSI for approval together, to demonstrate their quality and conformity with the Standards.

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors for quality assurance and to benefit from the capabilities of the CIS.

4 The Marking Scheme

4.1 General guidance

This section describes the role and place of the Marking Scheme, how the Experts will assess Competitors' work as demonstrated through the Test Project, and the procedures and requirements for marking.

The Marking Scheme is the pivotal instrument of the WorldSkills Competition, in that it ties assessment to the standard that represents each skill competition, which itself represents a global occupation. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards.

By reflecting the weightings in the Standards, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill competition and its assessment needs, it may initially be appropriate to develop the Marking Scheme in more detail as a guide for Test Project design. Alternatively, initial Test Project design can be based on the outline Marking Scheme. From this point onwards the Marking Scheme and Test Project should be developed together.

Section 2.1 above indicates the extent to which the Marking Scheme and Test Project may diverge from the weightings given in the Standards, if there is no practicable alternative.

For integrity and fairness, the Marking Scheme and Test Project are increasingly designed and developed by one or more Independent Test Project Designer(s) with relevant expertise. In these instances, the Marking Scheme and Test Project are unseen by Experts until immediately before the start of the skill competition, or competition module. Where the detailed and final Marking Scheme and Test Project are designed by Experts, they must be approved by the whole Expert group prior to submission for independent validation and quality assurance. Please see the Competition Rules for further details.

Experts and Independent Test Project Designers are required to submit their Marking Schemes and Test Projects for review, verification, and validation well in advance of completion. They are also expected to work with their Skill Advisor, reviewers, and verifiers, throughout the design and development process, for quality assurance and in order to take full advantage of the CIS's features.

In all cases a draft Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition. Skill Advisors actively facilitate this process.

4.2 Assessment Criteria

The main headings of the Marking Scheme are the Assessment Criteria. These headings are derived before, or in conjunction with, the Test Project. In some skill competitions the Assessment Criteria may be similar to the section headings in the Standards; in others they may be different. There will normally be between five and nine Assessment Criteria. Whether or not the headings match, the Marking Scheme as a whole must reflect the weightings in the Standards.

Assessment Criteria are created by the person or people developing the Marking Scheme, who are free to define the Criteria that they consider most suited to the assessment and marking of the Test Project. Each Assessment Criterion is defined by a letter (A-I). **The Assessment Criteria, the allocation of marks, and the assessment methods, should not be set out within this Technical Description. This is because the Criteria, allocation of marks, and assessment**

methods all depend on the nature of the Marking Scheme and Test Project, which is decided after this Technical Description is published.

The Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria and Sub Criteria.

The marks allocated to each Criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each Aspect within that Assessment Criterion.

4.3 Sub Criteria

Each Assessment Criterion is divided into one or more Sub Criteria. Each Sub Criterion becomes the heading for a WorldSkills marking form. Each marking form (Sub Criterion) contains Aspects to be assessed and marked by Measurement or Judgement, or both Measurement and Judgement.

Each marking form (Sub Criterion) specifies both the day on which it will be marked, and the identity of the marking team.

4.4 Aspects

Each Aspect defines, in detail, a single item to be assessed and marked, together with the marks, and detailed descriptors or instructions as a guide to marking. Each Aspect is assessed either by Measurement or by Judgement.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it. The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the Standards. This will be displayed in the Mark Allocation Table of the CIS, in the following format, when the Marking Scheme is reviewed from C-8 weeks. (Section 4.1 refers.)

		CRITERIA								TOTAL MARKS PER SECTION	WSSS MARKS PER SECTION	VARIANCE
STANDARDS SPECIFICATION SECTION		A	B	C	D	E	F	G	H			
	1	5.00								5.00	5.00	0.00
	2		2.00					7.50		9.50	10.00	0.50
	3								11.00	11.00	10.00	1.00
	4			5.00						5.00	5.00	0.00
	5				10.00	10.00	10.00			30.00	30.00	0.00
	6		8.00	5.00				2.50	9.00	24.50	25.00	0.50
	7			10.00				5.00		15.00	15.00	0.00
TOTAL MARKS		5.00	10.00	20.00	10.00	10.00	10.00	15.00	20.00	100.00	100.00	2.00

4.5 Assessment and marking

There is to be one marking team for each Sub Criterion, whether it is assessed and marked by Judgement, Measurement, or both. The same marking team must assess and mark all Competitors. Where this is impracticable (for example where an action must be done by every Competitor simultaneously, and must be observed doing so), a second tier of assessment and marking will be put in place, with the approval of the Competitions Committee Management Team. The marking teams must be organized to ensure that there is no compatriot marking in any circumstances. (Section 4.6 refers.)

4.6 Assessment and marking using Judgement

Judgement uses a scale of 0-3. To apply the scale with rigour and consistency, Judgement must be conducted using:

- benchmarks (criteria) for detailed guidance for each Aspect (in words, images, artefacts, or separate guidance notes). This is documented in the Standards and Assessment Guide.
- the 0-3 scale to indicate:
  - 0: performance below industry standard
  - 1: performance meets industry standard
  - 2: performance meets and, in specific respects, exceeds industry standard
  - 3: performance wholly exceeds industry standard and is judged as excellent

Three Experts will judge each Aspect, normally simultaneously, and record their scores. A fourth Expert coordinates and supervises the scoring, and checks their validity. They also act as a judge when required to prevent compatriot marking.

4.7 Assessment and marking using Measurement

Normally three Experts will be used to assess each Aspect, with a fourth Expert supervising. In some circumstances the team may organize itself as two pairs, for dual marking. Unless otherwise stated, only the maximum mark or zero will be awarded. Where they are used, the benchmarks for awarding partial marks will be clearly defined within the Aspect. To avoid errors in calculation or transmission, the CIS provides a large number of automated calculation options, the use of which is mandated.

4.8 The use of Measurement and Judgement

Decisions regarding the choice of criteria and assessment methods will be made during the design of the competition through the Marking Scheme and Test Project.

4.9 Skill assessment strategy and procedures

WorldSkills is committed to continuous improvement including reviewing past limitations and building on good practice. The following skill assessment strategy and procedures for this skill competition take this into account and explain how the marking process will be managed.

The assessment criteria are clear concise aspect specifications which explain exactly how and why a particular mark is awarded.

The Independent Test Project Designer is responsible for developing the Marking Scheme to be applied by the Experts, based on the WorldSkills Occupational Standards. An accompanying set of marking schedule should also be provided to assist the marking teams with their assessment.

The Independent Test Project Designer will decide on the marking criteria and the dimensional tolerances of the Marking Form and the Mark Summary Form.

The Chief Expert will divide the Experts into teams for the purpose of marking and setting up the marking schedule in accordance with the requirements of section 5.3. Every team will mark a similar percentage of marks. The Experts are divided into marking teams made up of Experts from at least three different continents with suitable industry and competition experience and are led by an English-speaking Expert.

All teams should be on the workshop providing assistance to the Competitors where required and observing for illegal or unsafe actions by Competitors.

For paper marking the Experts must sign the written hard copy assessment sheet of their compatriot Competitor daily and use it to verify with the data entered into the CIS, then sign the Mark Entry Acceptance Form. This is done daily.

Primary clarification and dispute resolution are addressed by module ESR in the first instance, in order to ensure a tiered management structure.

The Chief Expert may choose not to mark Competitor's work but is responsible for clarifying disputes or inconsistencies in the final marking, if called upon by an Expert Lead. The Skill Competition Manager may also be involved in this process.

5 The Test Project

5.1 General notes

Sections 3 and 4 govern the development of the Test Project. These notes are supplementary.

Whether it is a single entity, or a series of stand-alone or connected modules, the Test Project will enable the assessment of the applied knowledge, skills, and behaviours set out in each section of the WSOS.

The purpose of the Test Project is to provide full, balanced, and authentic opportunities for assessment and marking across the Standards, in conjunction with the Marking Scheme. The relationship between the Test Project, Marking Scheme, and Standards will be a key indicator of quality, as will be its relationship with actual work performance.

The Test Project will not cover areas outside the Standards or affect the balance of marks within the Standards other than in the circumstances indicated by Section 2. This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards. Section 2.1 refers.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work. The Test Project will not assess knowledge of WorldSkills rules and regulations.

Most Test Projects and Marking Schemes are now designed and developed independently of the Experts. They are designed and developed either by the Skill Competition Manager, or an Independent Test Project Designer, normally from C-12 months. They are subject to independent review, verification, and validation. (Section 4.1 refers.)

The information provided below will be subject to what is known at the time of completing this Technical Description, and the requirement for confidentiality.

Please refer to the current version of the Competition Rules for further details.

5.2 Format/structure of the Test Project

The Test Project is a series of standalone modules.

5.3 Test Project design requirements

Test Projects should reflect the purposes, structures, processes, and outcomes of the occupational role they are based on. They should aim to be a small-scale version of that role. Before focusing on practicalities, SMTs should show how the Test Project design will provide full, balanced, and authentic opportunities for assessment and marking across the Standards, as set out in Section 5.1.

The Test Project documents are divided into two parts, part A and part B. Part A consists of the descriptions of the tasks. Part B consists of the instructions to the Competitors, specifications, and operating manuals of the equipment.

The Test Project may include any of the following standalone modules designed to test the skills of the Competitors:

Module 1 - Component fabrication and brazing;

Module 2 - Refrigeration equipment, installation, commissioning, and adjustment;

Module 3 - Air Conditioning equipment installation, commissioning, and adjustment;

Module 4 - Heat Pump equipment installation, commissioning, and adjustment;

Module 5 - Refrigerant fault finding and component replacement;

Module 6 - Electrical fault finding and component replacement.

Overall, the Test Project must:

- Be modular;
- Be in accordance with the current Technical Description;
- Be in accordance with the current WorldSkills Refrigeration Standards;
- Comply with WorldSkills requirements and numbering standards;
- Be accompanied by a Marking Scheme that is finalized at the Competition in accordance with section 4.6;
- Be supplied digitally and in hard copy;
- Contain a detailed material list;
- Be self-explanatory and include schematic diagrams and tables to minimize the requirement of translation;
- Be accompanied by proof of function/proof of construction/completion in the set time etc. – as appropriate to this skill category. For example, a photograph of a project done according to the Test Project within material, equipment, knowledge, and time constraints;
- The marking criteria must be designed to mark the Test Project objectively;
- The Competitor must independently carryout the required modules of the Test Project using the material and equipment provided by the Competition Organizer;
- Use low GWP refrigerants meeting Health, Safety, and Environment regulations;
- Use of fixed gauges in refrigeration circuit where possible for suction and discharge pressure is recommended

5.4 Test Project coordination and development

The Test Project MUST be submitted using the templates provided by WorldSkills International (www.worldskills.org/expertcentre). Use the Word template for text documents and DWG template for drawings.

5.4.1 Test Project coordination (preparation for Competition)

Coordination of the Test Project/modules will be undertaken by the Skill Competition Manager.

5.4.2 Who develops the Test Project/modules

The Test Project/modules are developed by an Independent Test Project Designer (ITPD) in collaboration with the Skill Competition Manager.

5.4.3 When is the Test Project developed

The Test Project/modules are developed according to the following timeline:

Time	Action
Ten (10) months prior to the Competition	The ITPD is identified and a Confidentiality Agreement between WSI and the ITPD is organized.
Six (6) months prior to the Competition	The Skill Competition Manager and Independent Test Project Designer agree on the content of the Test Project modules and finalize the consumables on the Infrastructure List.

Time	Action
Two (2) months prior to the Competition	The Test Project/modules are sent to the WorldSkills International Skills Competitions Administration Manager.
One (1) month prior to the Competiton	The Test Project/modules Part A "Module Descriptions and Instructions" are circulated via the WorldSkills website for translation.
At the Competition on C-4	The Test Project/modules Part B "Specifications and Drawings" are presented to Experts.
At the Competition on C-2	The Test Project/modules Part B "Specifications and Drawings" are presented to Competitors.

5.5 Test Project initial review and verification

The purpose of a Test Project is to create a challenge for Competitors which authentically represents working life for an outstanding practitioner in an identified occupation. By doing this, the Test Project will apply the Marking Scheme and fully represent the WSOS. In this way it is unique in its context, purpose, activities, and expectations.

To support Test Project design and development, a rigorous quality assurance and design process is in place (Competition Rules sections 10.6-10.7 refer.) Once approved by WorldSkills, the Independent Test Project Designer (ITPD) is expected to identify one or more independent expert(s), and trusted individuals initially to review the Independent Test Project Designer's ideas and plans, and subsequently to verify the Test Project, prior to validation.

A Skill Advisor will ensure and coordinate this arrangement, to guarantee the timeliness and thoroughness of both initial review, and verification, based on the risk analysis that underpins Section 10.7 of the Competition Rules.

5.6 Test Project validation

The Skill Competition Manager coordinates the validation of the Test Project/modules and will ensure that it can be completed within the material, equipment, knowledge, and time constraints of Competitors.

5.7 Test Project circulation

The Test Project/modules Partg B are not circulated prior to the Competition. The Test Project/ modules Part B are presented to Experts on C-4 and to Competitors on C-2.

Test Project Part A "Module Descriptions and Instructions" are circulated via the WorldSkills website one (1) month prior to the competition for translation.

5.8 Test Project change

Due to the Test Project being developed by an Independent Test Project Designer (ITPD), there is no change required to be made to the Test Project/modules at the Competition. Exceptions are amendments to technical errors in the Test Project documents and according to infrastructure limitations.

5.9 Material or manufacturer specifications

Specific material and/or manufacturer specifications required to allow the Competitor to complete the Test Project will be supplied by the Competition Organizer and are available from www.worldskills.org/infrastructure located in the Expert Centre. However, note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These items may include those for fault finding modules or modules not circulated.

The list of major equipment, components, and tools required for the Test Project are released in the Infrastructure List and relevant operating manuals in English are made available to all participating countries and regions at least three (3) months prior to the Competition. However, the details of the equipment/components required for some modules, for example fault-finding, may not be released prior to the Competition.

The project's piping and wiring diagrams and specifications are released with the Test Project at the competition.

6 Skill management and communication

6.1 Discussion Forum

Prior to the Competition, all discussion, communication, collaboration, and decision making regarding the skill competition must take place on the WorldSkills skill-specific Discussion Forum. (http://forums.worldskills.org). Skill related decisions and communication are only valid if they take place on the WorldSkills Discussion Forum. The Chief Expert (or an Expert Lead appointed by the Skill Management Team) will be the moderator for this Discussion Forum. Refer to the Competition Rules for the timeline of communication and competition development requirements.

6.2 Competitor information

All information for registered Competitors is available from the Competitor Centre (www.worldskills.org/competitorcentre).

This information includes:

- Competition Rules
- Technical Descriptions
- Mark Summary Form (where applicable)
- Test Projects (where applicable)
- Infrastructure List
- WorldSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

6.3 Test Projects and Marking Schemes

Circulated Test Projects will be available from www.worldskills.org/testprojects and the Competitor Centre (www.worldskills.org/competitorcentre).

6.4 Day-to-day management

The day-to-day management of the skill competition during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team. The Skill Management Team comprises the Skill Competition Manager, Chief Expert, and the Expert Leads. The Skill Management Plan is progressively developed in the six (6) months prior to the Competition and finalized at the Competition. The Skill Management Plan can be viewed in the Expert Centre (www.worldskills.org/expertcentre).

6.5 General best practice procedures

General best practice procedures clearly delineate the difference between what is a best practice procedure and skill-specific rules (section 9). General best practice procedures are those where Experts and Competitors CANNOT be held accountable as a breach to the Competition Rules or skill-specific rules which would have a penalty applied as part of the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System. In some cases, general best practice procedures for Competitors may be reflected in the Marking Scheme.

Task/topic	Operational best practices
Experts communication with Competitors	Refer to Competition Rule 7.3.3 Compatriot Communication and Contact. • To support this rule, Experts are to meet for at least 30 minutes each morning from C-2 to C4, before the Competitors are permitted into the workshop.
Assessment	• Experts are to use the Competitor's measuring equipment during the marking process if requested by the Competitor.

7 Skill-specific safety requirements

7.1 Personal Protective Equipment

Refer to WorldSkills Health, Safety, and Environment Policy and Regulations for Host country or region regulations.

Task	Clear safety glasses with side protection	Coloured Brazing goggles or glasses with side protection (shade 3)	Electrical protection gloves (≥2 x voltage)	Heat protection gloves
General PPE for safe areas				
PPE within the workstation	√			
Cutting, filing, drilling	√			
Handle refrigerants	√			
Flame brazing		√		√
Pressure testing with dry nitrogen	√			
Testing for/with live electrical voltage and current	√		√	

Task	Cut protection gloves	Insulated safety shoes with protective cap	Sturdy shoes with closed toe and heel	Tight fitting non-combustible work clothes (long sleeves & trousers)	Ear plugs s for noise protection
General PPE for safe areas			√		√
		√		√	

Task	Cut protection gloves	Insulated safety shoes with protective cap	Sturdy shoes with closed toe and heel	Tight fitting non-combustible work clothes (long sleeves & trousers)	Ear plugs s for noise protection
PPE within the workstation					
Cutting, filing, drilling	√	√		√	
Handle refrigerants	√	√		√	
Flame brazing		√		√	
Pressure testing with dry nitrogen	√	√		√	
Testing for/ with live electrical voltage and current		√		√	

- Competitors must keep their work area clear of obstacles and their floor area clear of any material, equipment, or items likely to cause someone to trip, slip, or fall;

8 Materials and equipment

8.1 Infrastructure List

The Infrastructure List details all equipment, materials, and facilities provided by the Competition Organizer.

The Infrastructure List is available at www.worldskills.org/infrastructure.

The Infrastructure List specifies the items and quantities requested by the Skill Management Team for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These items may include those for fault finding modules or modules not circulated.

At each Competition, the Skill Management Team must review and update the Infrastructure List in preparation for the next Competition. The Skill Competition Manager must advise the Director of Skills Competitions of any increases in space and/or equipment.

At each Competition, the Technical Observer must audit the Infrastructure List that was used at that Competition for the upcoming WorldSkills Competition.

The Infrastructure List does not include items that Competitors and/or Experts are required to bring and items that Competitors are not allowed to bring – they are specified below.

8.2 Competitors toolbox

Competitors are not allowed to send a toolbox to the Competition. All tools are provided by the Competition Organizer.

8.3 Materials, equipment, and tools supplied by Competitors

It is not applicable for Competitors to bring materials, equipment, and tools to the Competition.

However, Competitors are required to supply their own Personal Protective Equipment listed below, as specified in section 7 skill-specific safety requirements:

- Insulated safety shoes with protective cap
- Tight fitting non-combustible work clothes (long sleeves and long trousers)

All of the other Personal Protective Equipment specified in section 7 skill-specific safety requirements will be provided by Competition Organizer.

8.4 Materials, equipment, and tools supplied by Experts

Experts are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

Experts are responsible that Interpreters bring their PPE.

- Insulated safety shoes with protective cap

• Tight fitting non-combustible work clothes (long sleeves and long trousers)

All of the other Personal Protective Equipment specified in section 7 skill-specific safety requirements will be provided by Competition Organizer.

8.5 Materials and equipment prohibited in the skill area

Competitors and Experts are prohibited to bring any materials or equipment not listed in section 8.3 and section 8.4.

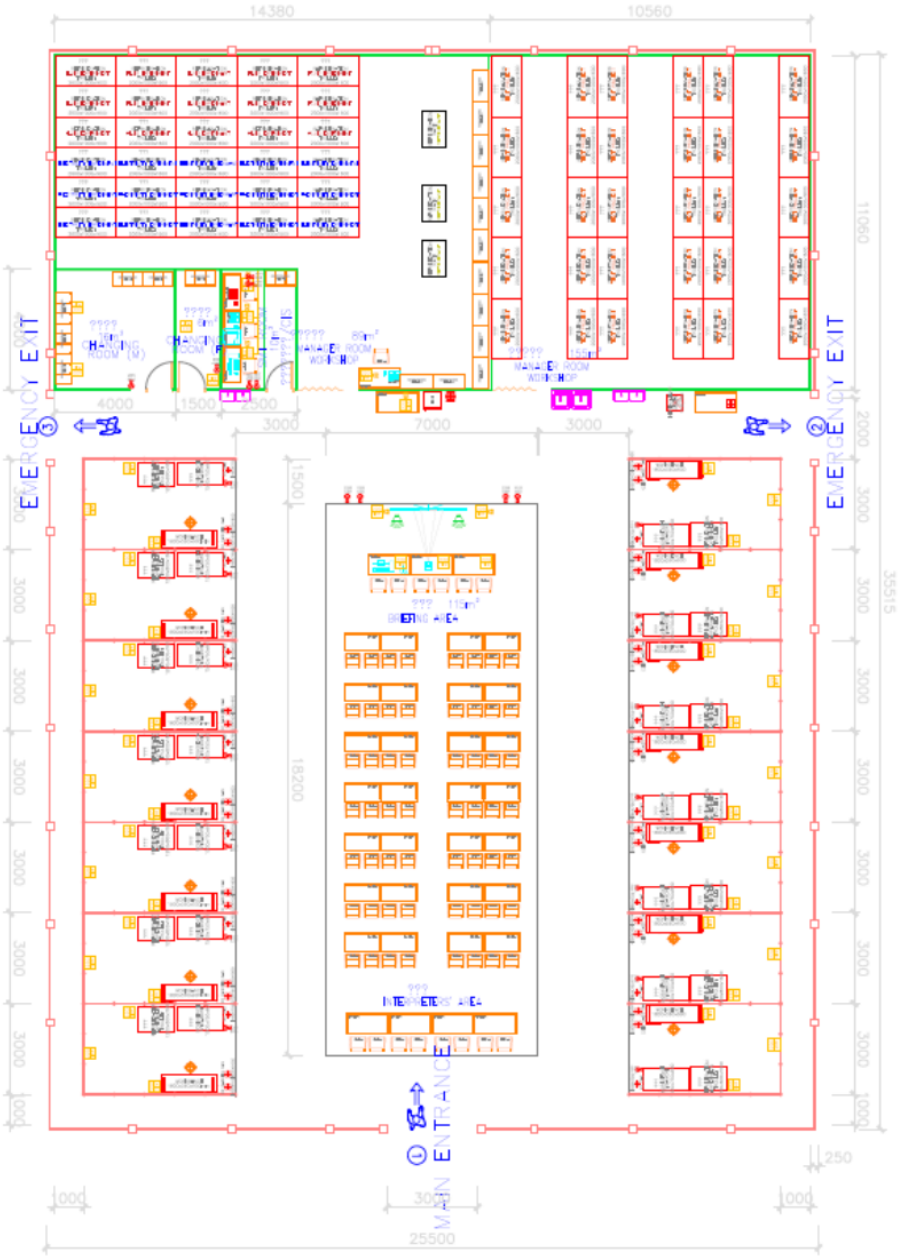
8.6 Proposed workshop and workstation layouts

Workshop layouts from previous competitions are available at www.worldskills.org/sitelayout.

Example workshop layout

The general layout of the workshop venue is as below, ensuring that there is sufficient space for the Competitors working booth, equipment storage, change rooms and offices as defined in below,

which should not be less than 1000 m² for 28 Competitors in two shifts. For visitors it is desirable to have as many open barriers as possible to have a view of the Competitors work.



9 Skill-specific rules

9.1 General notes

Skill-specific rules cannot contradict or take priority over the Competition Rules. They do provide specific details and clarity in areas that may vary from skill competition to skill competition. This includes but is not limited to personal IT equipment, data storage devices, Internet access, procedures and workflow, and documentation management and distribution. Breaches of these rules will be solved according to the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System.

9.2 Skill-specific rules

Task/topic	Skill-specific rule
Experts communication with Competitors	Refer to Competition Rule 7.3.3 Compatriot Communication and Contact. • To support this Rule and prevent confusion during competition time about whether the Expert talking to a Competitor is a compatriot or not, no Expert is to communicate with any Competitor by themselves. That is, during the competition time, at least 2 Experts must be present during all communication with a Competitor including their compatriot Competitor.
Test Project documentation	Refer to Competition Rule 10.9 Test Project Confidentiality
Use of technology – memory sticks	Refer to Competition Rule 10.9 Test Project Confidentiality • To support this rule, Competitors, Experts and Interpreters are not allowed to bring their own memory sticks into the workshop or remove supplied memory sticks from the workshop.
Use of technology – laptops and mobile phones	Refer to Competition Rule 10.9 Test Project Confidentiality. To support this rule: • Competitors, Experts, and Interpreters are not allowed to bring personal laptops, tablets or mobile phones into the workshop from C-4 until C+1. If they do, they must store them in their locker until they leave the competition workshop at lunch time or the end of the day. If taken at lunchtime they must be replaced on return to the workshop. • Experts and Interpreters are not allowed to use personal laptops/ tablets for the translation of the competition documentation. Translations are to be hand written onto the relevant documents. • During the competition times, Competitors, Experts and Interpreters are not permitted access or use of mobile phones to make or receive phone calls, messages or emails, to access the internet or take photos or videos. They can access them during their lunch time.

Task/topic	Skill-specific rule
	• Experts cannot use mobile phones within the competition workshop during C-4 to C4 for any communications. Any exceptions are to be approved by the Skill Competition Manager and the Chief Expert.
Use of technology – personal photo and video taking devices	Refer to Competition Rule 13.3.1 Filming and Photography and 13.2.2 Other Accredited Personnel To support these rules: • Competitors, Experts, and Interpreters are only allowed to use personal photo and video taking devices inside the workshop at the end of the competition as scheduled on C4. If this occurs before then, the device is locked way until C+1. • Visitors may film and photograph the skill competitions from outside the workshop for their own private use for a limited time (up to 5 minutes at time) and are moved on if the Competitor or Expert feels uncomfortable.
Use of technology - during assessment	• Experts are only allowed to use the supplied laptops/tablets for the marking process with the approval of the Skill Competition Manager and the Chief Expert. • Personal devices cannot be used.
Tools/infrastructure	The Technical Description section 8 Materials and Equipment, states that all of the required equipment, tools and materials for the Competitors to complete the Test Project are to be provided by the Competition Organizer and must be used by the Competitors. To clarify and support this requirement: • The Competitors must not use any other equipment, tools and/or materials. • Checks are carried out of supplied toolboxes on C-2 and C1 to C4 by Expert teams (not Workshop Manager/ Assistant) to ensure other tools and materials have not been added. If other tools and materials are found, they are removed. • The equipment, tools and materials supplied must be checked against the Infrastructure List by the Competitors during the familiarization session on C-2. Once checked and signed off by the Competitors, additional materials may be provided if available and approved by the Skill Competition Manager and the Chief Expert, but will result in a loss of marks as specified in the Marking Scheme. • Tools and materials are to be used only for the purpose intended, for example copper pipe is not to be cut up and used to make saddles or supports.
Templates, aids, etc.	• Competitors are not allowed to bring templates and aids to the Competition that may give them an unfair advantage.

Task/topic	Skill-specific rule
Familiarization session	• Competitors must check and sign off on their workstation clip board records that they received all the equipment, tools and materials on the infrastructure list by themselves. Experts must not be involved in this directly with their compatriot Competitor or assist other Competitors. • Competitors must also check and sign off on their workstation clip board records the following equipment: ◦ Nitrogen, Oxygen and Acetylene cylinder pressures; ◦ Operation of brazing equipment; ◦ LPG and refrigerant cylinder weight; ◦ Operating vacuum of vac pump, with service gauges/lines and vacuum meter on a recovery cylinder; ◦ Dry nitrogen regulator maximum outlet pressure. • During this time, the Expert marking teams will observe and sign off the Competitor's equipment checks on their workstation clip board records, for example vacuum pump test. • Any identified missing or inadequate equipment, tools, and materials are provided or replaced as necessary to ensure all competitors have the same resources. • Once checked and signed off by the Competitors, additional tools and materials may be provided if available and approved by the Skill Competition Manager and the Chief Expert, but will result in a loss of marks as specified in the Marking Scheme.
Assessment	During the competition: • If a Competitor's pressure test is marked as failed then they will not be permitted to evacuate the system and no further marks for the refrigeration aspects are awarded UNTIL the pressure test is passed. • If a Competitor's vacuum test is marked as failed then they will not be permitted to charge the system with refrigerant and no further refrigeration marks are awarded UNTIL the vacuum test it is passed. • Experts must record the time immediately when an issue arises which may result in a Competitor's requiring extra time and also the time when the issue is resolved.

Task/topic	Skill-specific rule
Health, safety and environment	Refer to the WorldSkills Health, Safety, and Environment policy, guidelines document and the Technical Description for Personal Protective Equipment (PPE) requirements. To support these requirements: • If a Competitor is observed by an Expert team to be working unsafely and/or not using the required PPE, the Experts must immediately advise the Competitor to correct the situation and record it on the Competitor's workstation clip board records. • Mark deductions for unsafe work and incorrect use of PPE are to be entered, based on the Competitor's workstation clip board records, on a daily/task basis at the end of each day/task, NOT at the end of the competition.

10 Visitor and media engagement

10.1 Engagement methods

Following is a list of possible ways to maximize visitor and media engagement:

- Interactive media display of trade;
- Posters and information bulletin boards in prominent locations;
- Display screens with footage of all Competitors;
- Presentations by sponsors in the VIP village;
- A working demonstration project be put on display during Competition to engage the visitor's interest.

11 Sustainability

11.1 Sustainable practices

This skill competition will focus on the sustainable practices below:

- Material recycling;
- Energy reduction, and innovation;
- Use of “green” materials when possible;
- No shipment of toolboxes;
- Re-use of completed Test Projects after Competition;
- Use refrigerants that have a low GWP value that results in less than 2000 equivalent CO2 level;
- Use alternative metal for heat exchanger fabrication e.g. Aluminium.
- Minimize brazing fluid loss

Example formulae:

Equivalent CO2 value = refrigerant GWP x refrigerant quantity in the system.

Example 1 R134a GWP = 1430

Therefore, Equivalent CO2 value = 1430 x 2.5 kg (refrigerant system charge) = 3575 equivalent CO2 level,

or 1430 x 1.5 kg = 2145

Other Examples: Equivalent CO2 value = refrigerant GWP x refrigerant quantity in the system

R410A GWP = 2088 x 0.83 kg (refrigerant system charge) = 1733 CO2 level

R32 GWP = 670 x 0.83 kg = 556 CO2 level

12 References for industry consultation

12.1 General notes

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/)
- ESCO: (https://ec.europa.eu/esco/portal/home)
- O*NET OnLine (www.onetonline.org/)

12.2 References

This WSOS (Section 2) 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.

ILO 3115

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 Lyon 2024.

Organization	Contact name
Emerson Canada	Alain Mongrain, Business Development; Eastern Canada

13 Appendix

13.1 Appendix information

Not applicable.