

# TECHNICAL DESCRIPTION

## REFRIGERATION AND AIR CONDITIONING



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international

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WorldSkills International, by a resolution of the Technical 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:

<b>1.</b>	<b>INTRODUCTION .....</b>	<b>2</b>
<b>2.</b>	<b>COMPETENCY AND SCOPE OF WORK .....</b>	<b>2</b>
<b>3.</b>	<b>THE TEST PROJECT .....</b>	<b>4</b>
<b>4.</b>	<b>SKILL MANAGEMENT AND COMMUNICATION.....</b>	<b>8</b>
<b>5.</b>	<b>ASSESSMENT .....</b>	<b>8</b>
<b>6.</b>	<b>SKILL-SPECIFIC SAFETY REQUIREMENTS .....</b>	<b>10</b>
<b>7.</b>	<b>MATERIALS &amp; EQUIPMENT .....</b>	<b>10</b>
<b>8.</b>	<b>MARKETING THE SKILL TO VISITORS AND MEDIA.....</b>	<b>12</b>

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John Shiel  
Chair Technical Committee



Stefan Praschl  
Vice Chair Technical Committee

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## **1. INTRODUCTION**

### **1.1 Name and description of skill**

1.1.1 The name of the skill is

Refrigeration and Air Conditioning

1.1.2 Description of skill

The refrigeration (HVAC/R) technician deals with the installation, commissioning, maintenance, fault finding and repair of refrigeration systems which transfer heat by means of the vapour and compression refrigeration cycle; e.g. refrigeration systems as applied to cool rooms, freezer rooms, air-conditioning systems, liquid coolers and heat pumps. Systems must operate on a commonly used HFC refrigerant or commonly used natural refrigerant.

### **1.2 Scope of application**

1.2.1 Every Expert and Competitor must know this Technical Description.

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

### **1.3 Associated documents**

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

- WSI - Competition Rules
- WSI - Online resources as indicated in this document
- WorldSkills Refrigeration Standards
- Host Country - Health and Safety regulations

## **2. COMPETENCY AND SCOPE OF WORK**

The Competition is a demonstration and assessment of the competencies associated with this skill. The Test Project consists of practical work only.

### **2.1 Competency specification**

#### **Install Refrigeration and Air Conditioning Systems**

Knowledge and understanding:

- Understanding of basic principles of refrigeration
- Understanding of Worldskills Refrigeration standards
- Understanding of basic plumbing principles found in refrigeration and air conditioning systems, including drainage and secondary refrigerant circuits
- Understanding of electrical principles
- Understanding of refrigeration piping diagrams
- Understanding of electrical diagrams

Competitors shall be able to:

- Interpret piping diagrams, electrical diagrams, plans and specifications
- Complete a list of components and materials required for installation
- Braze copper pipe and dissimilar metals commonly found in refrigeration air conditioning systems such as brass and steel
- Fabrication of system components

- Install primary and secondary refrigerant piping to Worldskills standards
- Install primary and secondary refrigerant flow controls and regulators to Worldskills standards
- Install electrical controls and components
- Install electronic controls and associated devices such as probes, transducers and sensors
- Install electrical wiring to Worldskills standards
- Install ancillary systems found in refrigeration and air conditioning systems such as drainage
- Pressure test installed system to Worldskills standards
- Evacuate installed system to Worldskills standards
- Evaluate electrical wiring for safe operation prior to energising
- Carry out all works safely

### **Commissioning Refrigeration and Air Conditioning Systems**

Knowledge and understanding:

- Interpretation of design parameters
- Understanding of Worldskills Refrigeration standards
- Understanding of basic principles of refrigeration
- Safe handling of refrigerants

Competitors shall be able to:

- Charge the system with correct type and amount of refrigerant for efficient operation
- Assess the refrigeration installation for correct operation
- Assess the air distribution system for correct operation
- Assess the electrical installation for correct operation
- Adjust refrigerant controls and flow devices for optimum system performance
- Adjust electrical and electronic controls for optimum system performance
- Balance air distribution systems
- Measuring and recording system operating parameters
- Carry out all works safely

### **Fault Finding Refrigeration and Air Conditioning Systems**

Knowledge and understanding:

- Understanding of basic principles of refrigeration
- Understanding of electrical principles
- Interpretation and understanding of refrigeration piping diagrams
- Interpretation and understanding of electrical wiring diagrams

Competitors shall be able to:

- Assess the refrigeration system for correct operation
- Adjust refrigerant controls and flow devices for optimum system performance
- Replace faulty refrigeration system components
- Assess the air distribution system for correct operation
- Adjust the air distribution system components
- Replace faulty air distribution components
- Evaluate electrical wiring for safe operation prior to energising
- Assess the electrical installation for correct installation
- Adjust electrical and electronic controls for optimum system performance
- Replace faulty electrical and electronic control components
- Reclaim refrigerant safely from system
- Drain and refill compressor lubricant
- Pressure test system to Worldskills standards
- Evacuate refrigeration system to Worldskills standards
- Charge the system with correct type and amount of refrigerant for efficient operation
- Carry out all works safely

## 2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.

2.2.2 Knowledge of rules and regulations is not examined.

## 2.3 Practical work

The Test Project is designed to test the skills of Competitors as indicated in paragraph 2.1 *Competency Specification*.

- Refrigeration pipe-work
- Electrical wiring
- Component & system installation
- Commissioning & adjustment
- Fault finding
- Repair and part replacement
- Refrigerant recovery and control
- Work practices and safety

## 3. THE TEST PROJECT

### 3.1 Format / structure of the Test Project

The Test Project is a series of standalone modules.

The Test Project will be divided into 2 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: Refrigerant fault finding and component replacement
- Module 5: Electrical fault finding and component replacement

### 3.2 Test Project design requirements

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 scale that will be finalised at the Competition in accordance with Subsection 5.1.
- Be supplied digitally and in hard copy
- Contain a detailed material list
- Be self-explanatory and include schematic diagrams and tables to minimise 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 carry out the required modules of the Test Project using the material and equipment provided by the Competition Organiser.

### 3.3 Test Project development

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

#### 3.3.1 Who develops the Test Project / modules

The Test Project / modules are developed by:

The Test Project modules are developed by a team of Experts. The development team will be elected by ballot at the previous Competition. The timeline for the Test Project modules development is set out in paragraph 3.3.3.

The refinement of the Test Project modules is open to all Experts who volunteer to participate on the Discussion Forum.

#### 3.3.2 How and where is the Test Project / modules developed

The Test Project / modules are developed independently.

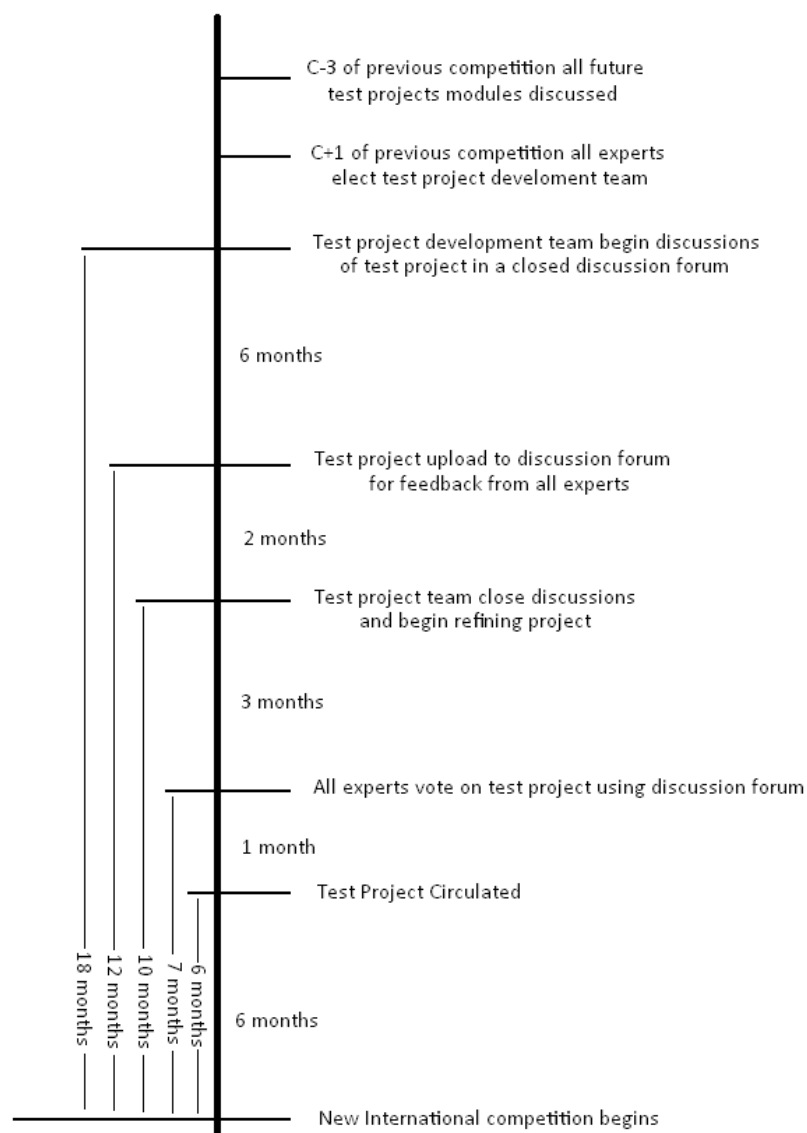
Proposed Test Project modules for the next Competition are invited from all Experts. The Test Project modules for the next Competition will be proposed at the completion of each Competition, four (4) Experts will be elected to develop the Test Project modules prior to a ballot being undertaken on the Discussion Forum. All Experts will have the right to vote. The Chief Expert and the Test Project development team are entrusted to develop the selected Test Project modules for the next Competition by contributing to the Discussion Forum in accordance with the current Technical Description.

#### 3.3.3 When is the Test Project developed

The Test Project is developed as per the follows timeline:

The following schedule shall be adhered to.

Time	Item
At the previous Competition (C-3)	Discuss Test Projects for the next Competition
At the previous competition (C+1)	Elect 4 Experts to form the Test Project development team
18 months prior to the Competition	TP development team begins discussions on a closed discussion forum
12 months prior to the Competition	Upload proposed TP modules on the forum for discussion
10 months prior to the Competition	TP development team closes the open discussion and refines the project based on the comments
10 months – 7 months prior to the Competition	The refined TP is built and validated according to paragraph 3.5 of the TD
7 months	Experts vote on the final Test Project
6 months	Test Project is circulated on the WSI website



The Chief Expert will forward the completed Test Project to the Jury President so that material availability can be confirmed at the Technical Committee meeting that is held prior to the WorldSkills Competition.

The Chief Expert will ensure that all required communication occurs between all Experts and participating countries/regions.

### 3.4 Test Project marking scheme

Each Test Project must be accompanied by a marking scheme proposal based on the assessment criteria defined in Section 5.

- 3.4.1 The marking scheme proposal is developed by the person(s) developing the Test Project. The detailed and final marking scheme is developed and agreed by all Experts at the Competition.
- 3.4.2 Marking schemes should be entered into the CIS prior to the Competition.

### **3.5 Test Project validation**

The Test Project is validated by proof of function/construction/completion in the set time as appropriate to this skill category. Photographs and operational specification of the completed Test Project modules including material & equipment knowledge is to be presented within the time constraints of paragraph 3.3.3.

### **3.6 Test Project selection**

The Test Project is selected as follows:

The Test Project is selected by vote of Experts at the current Competition.

Development of the Test Projects will be done by elected Experts. All Experts will have the right to vote on the selected Test Project.

### **3.7 Test Project circulation**

The Test Project is circulated via WorldSkills International website as follows:

The Test Project is circulated via WorldSkills International website six months before the current Competition.

Part A (Task Descriptions) of the Test Project will be provided to participating countries at least six months prior to the WorldSkills Competition via the Technical Delegates of each country.  
Part B (Competitor Instructions) of the Test Project is given to the Competitors at the Competition.

The Marking Scheme is to be circulated on the forum at least three (3) months prior to current Competition.

### **3.8 Test Project coordination (preparation for Competition)**

Coordination of the Test Project will be undertaken by:

Chief Expert in coordination with the Test Project development team.

### **3.9 Test Project change at the Competition**

A minimum of 30% change will be decided by all the Experts at the Competition taking into consideration the materials available.

Part B of the Test Project is given to the Competitors at the Competition. This equates to 10% of the marks. A further 20% will be changed to the circulated modules.

### **3.10 Material or manufacturer specifications**

Full operating manual, wiring diagrams and specifications of the major equipment must be submitted to all participating countries at least 6 months prior to the Competition.

All material-related requirements and manufacturers specifications shall be provided to the Competitors at the same time as the Test Project is given 12 months before the Competition.



## 4. SKILL MANAGEMENT AND COMMUNICATION

### 4.1 Discussion Forum

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

### 4.2 Competitor information

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

This information includes:

- Competition Rules
- Technical Descriptions
- Test Projects
- Other Competition-related information

### 4.3 Test Projects

Circulated Test Projects will be available from [worldskills.org](http://www.worldskills.org) (<http://www.worldskills.org/testprojects>) and the Competitor Centre (<http://www.worldskills.org/competitorcentre>).

### 4.4 Day-to-day management

The day-to-day management is defined in the Skill Management Plan that is created by the Skill Management Team led by the Chief Expert. The Skill Management Team comprises the Jury President, Chief Expert and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalised at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre (<http://www.worldskills.org/expertcentre>).

## 5. ASSESSMENT

This section describes how the Experts will assess the Test Project / modules. It also specifies the assessment specifications and procedures and requirements for marking.

### 5.1 Assessment criteria

This section defines the assessment criteria and the number of marks (subjective and objective) awarded. The total number of marks for all assessment criteria must be 100.

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
A	<a href="#">Component Fabrication</a>		12.5	12.5
B	<a href="#">Component &amp; System Installation</a>		20	20
C	<a href="#">Electrical installation</a>		15	15
D	<a href="#">Commissioning and adjustment</a>		17.5	17.5
E	<a href="#">Electrical Fault Find and Repair</a>		10	10
F	<a href="#">Refrigeration Fault Find and Repair</a>		10	10
G	<a href="#">Refrigerant recovery and control</a>		10	10
H	<a href="#">Work practices and safety</a>		5	5
<b>Total =</b>			<b>100</b>	<b>100</b>

## 5.2 Subjective marking

Not applicable

## 5.3 Skill assessment specification

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

Section	Description	Criterion (Modules)					Total
		1	2	3	4	5	
A	Component Fabrication	12.5					12.5
B	Component & System Installation		12.5	7.5			20
C	Electrical Installation		10	5			15
D	Commissioning & Adjustment		10	5	2.5		17.5
E	Electrical Fault Find & Repair					10	10
F	Refrigeration Fault Find & Repair				10		10
G	Refrigerant Recovery & Emission Control				10		10
H	Safety	1	1	1	1	1	5
Total =		13.5	33.5	18.5	23.5	11	100

	Marks Allocation		Total
Group 1	First day: 1A+1H	13.5	= 13.5 marks
Group 2	2nd day: 3B+3C+3D+3H	7.5+5+5+1	= 18.5 marks
Group 3	3rd day: 4D+4F+4G+4H+5E+5H	2.5+10+10+1+10+1	= 34.5 marks
Group 4	Last day: 2B+2C+2D+2H	12.5+10+10+1	= 33.5 marks

## 5.4 Skill assessment procedures

There is to be a majority agreement (minimum = 50 % + 1) from Experts on the accepted Competition marking scale.

The Experts will decide on the marking criteria and the dimensional tolerances of the Objective Marking Form, Subjective Marking Form and the Mark Summary Form.

The Chief Expert will then divide the Experts into teams for the purpose of marking and setting up the marking schedule in accordance with the requirements of subsection 5.3. Every team will mark a similar percentage of marks. Each team will be assigned to a workstation on a rotation basis by the DCE.

The teams will be divided into preference of expertise with each team being lead by an English speaking team leader.

All teams will be on the floor at once providing assistance to the Competitors where required and observing for illegal actions or unsafe actions by Competitors.

There will be 4 teams of which each team will mark approximately 25% of the project each. Each team will judge all aspects in their control.

The Experts must sign the written hard copy assessment sheet daily of their compatriot Competitor and use it to verify with the final copy from CIS system in the last day

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

The Chief Expert will not judge competitor's work but will be responsible for clarifying disputes or inconsistencies in the final marking, if called upon by the DCE.

## **6. SKILL-SPECIFIC SAFETY REQUIREMENTS**

Refer to Host Country Health & Safety documentation for Host Country regulations.

- All Competitors must use safety glasses when using any hand, power or machine tools or equipment likely to cause or create chips or fragments that may injure the eyes.
- Experts will use the appropriate personal safety equipment when inspecting, checking or working with a Competitor's project.

## **7. MATERIALS & EQUIPMENT**

### **7.1 Infrastructure List**

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

The Infrastructure List is online (<http://www.worldskills.org/infrastructure/>).

The Infrastructure List specifies the items & quantities requested by the Experts for the next Competition. The Competition Organiser will progressively update the Infrastructure List specifying the actual quantity, type, brand/model of the items. Items supplied by the Competition Organiser are shown in a separate column.

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Technical Director 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.

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.

### **7.2 Materials, equipment and tools supplied by Competitors in their toolbox**

Each Competitor must bring with them the necessary hand-tools of the trade required to complete the project, and there is no requirement for the host country to provide any additional tools.

### **7.3 Materials, equipment and tools supplied by Experts**

Competitors are not allowed to use tools supplied by Experts.

### **7.4 Materials & equipment prohibited in the skill area**

Competitors are not allowed to use their own materials for the work.



## **8. MARKETING THE SKILL TO VISITORS AND MEDIA**

### **8.1 Maximising 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

### **8.2 Sustainability**

- Material recycling
- Energy reduction and innovation
- Use of 'green' materials when possible
- Re-Use of completed Test Projects after Competition