



# TECHNICAL DESCRIPTION

# ELECTRICAL INSTALLATIONS



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.

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# 1 INTRODUCTION

## 1.1 NAME AND DESCRIPTION OF THE SKILL COMPETITION

1.1.1 The name of the skill competition is

Electrical Installations

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

An electrician works on commercial, residential, agricultural and industrial projects. There is a direct relationship between the nature and quality of the product required and the payment made by the customer. Therefore the electrician has a continuing responsibility to work professionally in order to meet the requirements of the customer and thus maintain and grow the business. Electrical installation is closely associated with other parts of the construction industry, and with the many products that support it, normally for commercial purposes.

The electrician works internally, including the homes of customers and on small and major projects. He or she will plan and design, select and install, commission, test, 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 electrician.

Whether the electrician is working alone or in a team the individual takes on a high level of personal responsibility and autonomy. From working to provide a safe and reliable electrical installation and maintenance service, in accordance with relevant standards, through to diagnosing malfunctions, programming and commissioning home and building automation systems, concentration, precision, accuracy and attention to detail every step in the process matters and mistakes are largely irreversible, costly and potentially life threatening.

With the international mobility of people the electrician faces rapidly expanding opportunities and challenges. For the talented electrician there are many commercial and international opportunities; however these carry with them the need to understand and work with diverse cultures and trends. The diversity of skills associated with electrical installations is therefore likely to expand.

## 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 – Competition Rules
- WSI – WorldSkills Standards Specification framework
- WSI – WorldSkills Assessment Strategy (when available)
- WSI – Online resources as indicated in this document
- Host Country – Health and Safety regulations



## 2 THE WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

### 2.1 GENERAL NOTES ON THE WSSS

The WSSS 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/WSSS](http://www.worldskills.org/WSSS)).

The skill competition is intended to reflect international best practice as described by the WSSS, and to the extent that it is able to. The Standards Specification 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 not be separate tests of knowledge and understanding.

The Standards Specification 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 Specification. The sum of all the percentage marks is 100.

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

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



## 2.2 WORLDSKILLS STANDARDS SPECIFICATION

SECTION		RELATIVE IMPORTANCE (%)
<b>1</b>	<b>Work organization and management</b>	<b>5</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Health and safety legislation, obligations and documentation</li> <li>• The principles of working safely with electricity</li> <li>• The situations when personal protective equipment must be used</li> <li>• The purposes, uses, care, maintenance and storage of all tools and equipment together with their safety implications</li> <li>• The purposes, uses, care and storage of materials</li> <li>• The importance of keeping a tidy work area</li> <li>• Sustainability measures applying to the use of 'green' materials and recycling</li> <li>• The ways in which working practices can minimize wastage and help to manage costs whilst maintaining quality</li> <li>• The principles of work flow and measurement</li> <li>• The significance of planning, accuracy, checking and attention to detail in all working practices</li> <li>• Impact of new technology</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Follow health and safety standards, rules and regulations</li> <li>• Diligently follow electrical safety procedures</li> <li>• Identify and use the appropriate personal protective equipment including safety footwear, ear and eye protection</li> <li>• Select, use, clean, maintain and store all tools and equipment safely</li> <li>• Select, use and store all materials safely</li> <li>• Identify and take care of expensive fixtures/fittings</li> <li>• Plan the work area to maximize efficiency and maintain the discipline of regular tidying</li> <li>• Measure accurately</li> <li>• Manage time effectively</li> <li>• Work efficiently and check progress and outcomes regularly</li> <li>• Establish and consistently maintain high quality standards and working processes</li> </ul>	
<b>2</b>	<b>Communication and Interpersonal Skills</b>	<b>10</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• The significance of establishing and maintaining customer confidence and trust</li> <li>• The importance of maintaining and keeping knowledge base up-to-date</li> <li>• The roles and requirements of related trades</li> <li>• The value of building and maintaining productive working relationships</li> <li>• Techniques of effective teamwork</li> <li>• The importance of swiftly resolving miss-understandings and conflicting demands</li> </ul>	



	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Interpret customer requirements and manage customer expectations positively</li> <li>• Provide advice and guidance on products/solutions e.g. technological advancements</li> <li>• Visualize and translate customer wishes making recommendations which meet/improve their design and budgetary requirements</li> <li>• Question customers closely/deeply to fully understand requirements</li> <li>• Provide clear instructions</li> <li>• Introduce related trades to support customer requirements</li> <li>• Produce written reports for customers and the organization</li> <li>• Produce a cost and time estimate for customers</li> <li>• Recognize and adapt to the changing needs of related trades</li> <li>• Work effectively as a member of a team</li> </ul>	
<b>3</b>	<b>Problem Solving, Innovation and Creativity</b>	<b>10</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• The common types of problem which can occur within the work process</li> <li>• Diagnostic approaches to problem solving</li> <li>• Trends and developments in the industry including new technology, standards and working methods e.g. 'smart house' and energy saving measures</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Check work regularly to minimize problems at a later stage</li> <li>• Identify problems originating from the work of a related trade e.g. heating pump, ventilation system etc.</li> <li>• Challenge incorrect information to prevent problems</li> <li>• Recognize and understand problems swiftly and follow a self-managed process for resolving</li> <li>• Recognize opportunities to contribute ideas to improve the solution and overall level of customer satisfaction</li> <li>• Demonstrate a willingness to try new methods and embrace change e.g. ready-made components</li> </ul>	
<b>4</b>	<b>Planning and Design</b>	<b>5</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Different types of standards, drawings, installation descriptions and manuals</li> <li>• Range of materials and installation techniques to be used in different environments</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Read, interpret and revise drawings and documentation including:             <ul style="list-style-type: none"> <li>• Layout and circuit drawings</li> <li>• Follow written instructions</li> <li>• Plan installation work using drawings and documentation provided</li> </ul> </li> </ul>	



5	Installation	30
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Ducting and wiring systems for commercial, domestic, residential agricultural and industrial use and when and where to use a specific ducting and/or wiring system</li> <li>• The range of electrical switchboards used for commercial, domestic, residential, agricultural and industrial uses and when and where to use a specific switchboard system</li> <li>• Types of electric lighting and heating systems for commercial, domestic residential and industrial use</li> <li>• Control devices and socket outlets used for commercial, domestic, residential, agricultural and industrial uses</li> <li>• Structured cabling systems including: computer network cabling, fire/burglar alarm (conventional and addressable), evacuation control (audio and optical), control and monitoring, access control ('stand-alone' and 'network supervised'), closed circuit television (cameras, lenses and attachment component, recorders and monitors)</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Select and install equipment and wire ways as per drawings and documentation provided</li> <li>• Install ducting and cabling systems on different surfaces as per manufacturer's instructions and current industrial standards</li> <li>• Select and install single and double insulated cables inside ducts, conduits and flexible conduits</li> <li>• Install and securely fix double insulated cables onto cable ladder, cable tray and different surfaces as per manufacturer's instructions and current industrial standards</li> <li>• Install metal and plastic ducting (trunking): accurately measure and cut duct at specified lengths/angles; assemble without distortion to joints and to specified tolerances</li> <li>• Assemble different termination adaptors, including glands onto duct and attach ducts, of different types, securely onto a surface</li> <li>• Install metal and plastic conduits/flexible conduits and attach securely onto surface, maintaining even radius bends, without distortion to conduit</li> <li>• Correct termination adaptors used for entry of conduits into boxes, boards and ducts</li> <li>• Install and securely attach different types of cable ladder and cable tray to a surface</li> <li>• Install electrical switchboards onto a surface in a secure way and assemble switchboard apparatus in a switchboard as per layout drawings/instructions to include: main switches, RCDs, MCBs, fuses, controlling equipment such as relays and timers and home and building automation devices</li> <li>• Terminate and install wiring inside a switchboard according to circuit drawings</li> <li>• Connect equipment as per instructions provided to include: structured cabling systems as per manufacturer's instructions and current industrial standards and regulations</li> </ul>	



6	Testing, Reporting and Commissioning	25
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Industrial regulations and standards applicable to different types of installations</li> <li>• Verification standards, methods and reports to be used to record verification results</li> <li>• Types of measuring instruments</li> <li>• Tools and software used for parameterization, programming and commissioning</li> <li>• The correct operation of the electrical installation in accordance with the planned specification and customer requirements</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Test installations before energizing to ensure personal and electrical safety to include: insulation resistance and earth continuity tests, correct polarity and complete a visual inspection</li> <li>• Test installations when energized by checking complete function on all equipment installed to ensure correct operation of new installation as per instructions</li> <li>• Set-up equipment to include: selecting and using the appropriate software for programming programmable relays, bus-system; creating necessary settings on devices such as timers and overload relays; programming programmable relays: downloading and importing applications required and programming bus-systems such as for example KNX</li> <li>• Set the installation to fully functioning and ensure customer can operate</li> </ul>	
7	Maintenance, Fault Finding and Repair	15
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Different types of installations for specific environments</li> <li>• Different generations of installations</li> <li>• The purpose of a specific installation</li> <li>• The customers' needs for various functions</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Adapt to changing circumstances</li> <li>• Troubleshoot electrical installations and identify faults including: short and open circuits, incorrect polarity, insulation resistance and earth continuity faults, incorrect settings on equipment and incorrect program on programmable devices</li> <li>• Diagnose electrical installations and identify problems including: bad connections, incorrect wiring, high loop impedance and equipment failure</li> <li>• Verify that an existing electrical installation still meets current standards</li> <li>• Use, test and calibrate measuring equipment including: insulation resistance, continuity and installation testers, multi, clamp and network cable testers</li> <li>• Repair and replace faulty components in electrical installations</li> <li>• Rewire and or repair faulty installations</li> </ul>	





## 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 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 judgment. These are referred to as **objective** and **subjective**, respectively. 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 Specification. The Test Project is the assessment vehicle for the skill competition, and also follows the Standards Specification. The CIS enables the timely and accurate recording of marks, and has expanding supportive capacity.

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

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors in order 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 standards that represent the skill. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards Specification.

By reflecting the weightings in the Standards Specification, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill 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 Specification, if there is no practicable alternative.

The Marking Scheme and Test Project may be developed by one person, or several, or by all Experts. The detailed and final Marking Scheme and Test Project must be approved by the whole Expert Jury prior to submission for independent quality assurance. The exception to this process is for those skill competitions which use an external designer for the development of the Marking Scheme and Test Project.

In addition, Experts are encouraged to submit their Marking Schemes and Test Projects for comment and provisional approval well in advance of completion, in order to avoid disappointment or setbacks at a late stage. They are also advised to work with the CIS Team at this intermediate stage, in order to take full advantage of the possibilities of the CIS.

In all cases the complete and approved Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition using the CIS standard spreadsheet or other agreed methods.

### 4.2 ASSESSMENT CRITERIA

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

Assessment Criteria are created by the person(s) developing the Marking Scheme, who are free to define 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 Mark Summary Form generated by the CIS will comprise a list of the Assessment 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 of assessment 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) has a specified day on which it will be marked.

Each marking form (Sub Criterion) contains either objective or subjective Aspects to be marked. Some Sub Criteria have both objective and subjective aspects, in which case there is a marking form for each.

### 4.4 ASPECTS

Each Aspect defines, in detail, a single item to be assessed and marked together with the marks, or instructions for how the marks are to be awarded. Aspects are assessed either objectively or subjectively and appear on the appropriate marking form.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it and a reference to the section of the skill as set out in the Standards Specification.

The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the skill in the Standards Specification. 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)

CRITERIA											TOTAL MARKS PER SECTION
STANDARD SPECIFICATION SECTIONS											
TOTAL MARKS PER CRITERION											100

SAMPLE OF TABLE FROM CIS



## 4.5 SUBJECTIVE MARKING

Subjective marking uses the 10 point scale below. To apply the scale with rigour and consistency, subjective marking should be conducted using:

- benchmarks (criteria) to guide judgment against each Aspect
- the scale to indicate:
  - 0: non attempt;
  - 1-4: below industry standard;
  - 5-8: at or above industry standard;
  - 9-10: excellence.

## 4.6 OBJECTIVE MARKING

A minimum of three experts will be used to judge each aspect. Unless otherwise stated only the maximum mark or zero will be awarded. Where they are used, partial marks will be clearly defined within the Aspect.

## 4.7 THE USE OF OBJECTIVE AND SUBJECTIVE ASSESSMENT

The final deployment of objective or subjective assessment will be agreed when the Marking Scheme and Test Project are finalized. The table below is advisory only for the development of the Test Project and Marking Scheme.

SECTION	CRITERION	MARKS		
		Subjective	Objective	Total
A	Safety (electrical and personal)	0	10	10
B	Commissioning and Function	0	25	25
C	Circuit design	0	10	10
D	Measurements	0	5	5
E	Installation of equipment and wire-ways	5	10	15
F	Wiring and termination	5	10	15
G	Installation testing	0	10	10
H	Programming	0	10	10
<b>Total</b>		<b>10</b>	<b>90</b>	<b>100</b>



## 4.8 COMPLETION OF SKILL ASSESSMENT SPECIFICATION

The Test Project assessment will be based on the following criteria:

- A. Personal safety during work and electrical safety on the completed installations on all modules;
- B. Testing, reporting and commissioning from every module will be assessed as described in the instructions for the various modules;
- C. Circuit design will be assessed on the functionality of the circuit and the cable selection. Both for safety and cost efficiency;
- D. Measurements and level/plumb will be assessed comparing drawings with the actual installations.

### Definition

- Level: Positioned horizontally to the device being checked;
- Plumb: Positioned vertically to the device being checked;
- All dimensions must be from specific reference lines (datum/centre lines);
- Cable and conduit measurements are to the centre of the cable/conduit;
- Duct and equipment measurements are to the centre or edge of the duct/equipment as shown on drawings.

TOLERANCES	
Level/plumb	bubble on or between lines on level, not outside
Measurement	+/- 2mm

E. Installation of equipment and wire-ways may be checked as but not limited to:

- Materials and wire-ways secured;
- Secure definition;
- PVC and Metal Conduit;
- At least one saddle must be placed between:
  - Termination point and bend;
  - Bend to bend;
  - Termination point to termination point;
- If the distance between any bend or termination point exceeds one meter then additional saddles must be placed for every metre added;
- Flexible Conduit: If flexible conduit is to be fixed, at least one saddle must be placed every 300mm;
- No damage on materials, cables, conduits etc.;
- Correct materials and wire-ways installed as per drawings;
- Materials and wire-ways assembled and installed as per manufacturers specification;
- No extra materials required during the competition;
- Installation is clean and tidy.

F. Wiring and terminations may focus on but not limited to:

- No copper visible when looking at the connection from a 90 degree position;
- No nicks or cuts in the copper conductors;
- No plastic insulation inside the termination;
- Terminations done correctly (no loose terminations, good electrical and mechanical connection) If ferrules are required the Competition Organizer must provide all equipment and materials to install;
- Neatness of wiring and looming in distribution boards;

G. Installation testing will be assessed as faults found or not found;

H. Programming will be assessed as functions completed or not completed.



## 4.9 SKILL ASSESSMENT PROCEDURES

The Chief Expert and the Deputy Chief Expert divides the Experts into marking teams. Each team must include at least one Expert who is experienced. Cultures and languages are also considered to ensure there is a range in each marking team.

Where possible all Experts will assess a similar percentage of marks.

No live testing or commissioning will take place without the attendance of two Experts.



## 5 THE TEST PROJECT

### 5.1 GENERAL NOTES

Sections three and four 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 skills in each section of the WSSS.

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

The Test Project will not cover areas outside the Standards Specification, or affect the balance of marks within the Standards Specification other than in the circumstances indicated by Section 2.

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.

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 Specification. Section 0 refers.

### 5.2 FORMAT/STRUCTURE OF THE TEST PROJECT

The Test Project will consist of three modules:

Module one – Domestic and Commercial installation module;

Module two – Programming;

Module three – Installation Testing.



## 5.3 TEST PROJECT DESIGN REQUIREMENTS

### General requirements

- All technical terms and descriptions used in the Test Project must be in accordance with internationally recognized standards;
- Cable and conduit measurements are to the centre of the cable/conduit;
- Duct and equipment measurements are to the centre or edge of the duct/equipment;
- All dimensions must be from specific reference lines (datum/centre lines);
- At least three different cable types must be used. For example:
  - Plastic sheath cable,
  - Flexible cable,
  - Steel wire armour;
- At least five different cable support systems must be used. For example:
  - Metal conduit,
  - PVC conduit,
  - Metal cable tray,
  - PVC trunking.

### The Test Project will consist of the following modules

#### Module one – Domestic and Commercial installation module

- 17 hours maximum including commissioning and equipment setup;
- The Competition Organizer must supply materials for the competition only;
- Module one to begin on day C1;
- Measurement marks will be measured progressively each day as indicated by the Test Project;
- Module one must be completely finished and marked by the end of C3;
- Module one will be installed on three walls and the ceiling of the Competitors cubicle;
- Module one will include programming of a small smart relay, this will be programmed as part of module one and included in the module timeframe;
- Module one will include home and building automation devices;
- For this module, function for home and building automation will be limited to manual functions only;
- Drawings to be circulated at least five months prior to the Competition.

#### Module two – Programming Exercise

- Two hours ;
- Module two completed by the end of C4;
- The devices for programming will be installed by the Competitor as part of module one;
- Equipment to be used for Module two is to be circulated at least five months prior to the Competition;
- Competitors are to be provided with descriptions, other necessary documentations and associated product files (product data base);
- The Infrastructure List must state the languages that the software, software version and databases will be available in;
- Programming exercise is to be completed in front of the general public;
- Final function tasks decided upon at the Competition;
- Programming will be limited to switches controlling lighting, dimming and blind control only;
- Competitors will be forbidden to have electronic storage devices in their work station during this module.





### Module three – Installation Testing

- One hour maximum;
- Installation testing board to be built by Competition Organizer;
- Module three and marking to be completed by day C3;
- A circuit diagram will be released with the Test Project and all Experts are required to bring this with a list of ten faults and any equipment that may be needed to create them;
- One set of faults will be selected at random for use.

#### **General instructions for all modules**

The Test Projects must reflect the standards from across the world and not one specific continent. Once all the Test Projects have been completed they must reflect aspects of electrical installations throughout the world.

Test specifications:

- Earth continuity resistance – The maximum resistance between the main incoming earth terminal and any point on the installation required to be earthed may not be more than 0.5  $\Omega$ ;
- Insulation resistance – The minimum resistance between any current carrying conductors and any other conductors to earth may not be less than one M $\Omega$ , tested at a voltage of 500 V DC with an insulation resistance tester;
- Polarity of socket outlets as per Host Country standard.


#### **Requirements for module one – Domestic and Commercial installation**

- This module must include lighting circuits, power outlet circuits;
- This module must include a design task for the Competitor;
- Installation of distribution boards and protection equipment must be included;
- Installation and equipment set up of programmable devices must be included;
- Installation of home and building automation devices must be included;
- This module may include fixed appliance circuits, Structured Cabling Systems, environment control or access equipment;
- Inspection and testing will be carried out and the test results documented before commissioning;
- Function testing may be carried out with the installation live at standard mains voltage of the Host Country.




### Requirements for module three – Installation testing

- Installation testing will consist of one installation with two sections. Section one will be supplied with an extra low voltage supply and can be tested live. Section two will receive no power;
- The test circuit designs must include the following circuits:
  - A lighting circuit;
  - A socket outlet circuit;
  - A power circuit (such as a heater or a cooker);
  - A control circuit (such as a pump control);
- A total of 10 faults must be installed;
- Installation testing faults must include as a minimum:
  - One high earth resistance fault;
  - One low insulation resistance fault;
  - One incorrect polarity fault;
  - One incorrect visual fault.
- Types of faults that may also be used are:
  - Incorrect timer settings;
  - Incorrect overload settings;
  - Short circuit faults;
  - Open circuit faults;
  - High resistance joints;
  - Interconnection;
- Competitors are required to bring their own test instruments to the Competition in order to be able to carry out the requirements of this module. They must meet the Host Country's/Region's health and safety requirements;
- All installation faults must be determined in accordance with "General Instructions for all modules, Test Specifications";
- Figure 1.1 is the standard symbols to be used for Installation Testing. The Competitor is to receive a copy of these symbols before module three commences;
- At the completion of C4 the Competitors will see the installed faults.

 **short circuit**

 **Open Circuit**

 **Low Insulation Resistance**

**S Incorrect setting (timer/overload)**

**V Value (incorrect component)**

 **Polarity / Phase Sequence**

 **High Resistance**

Figure 1.1

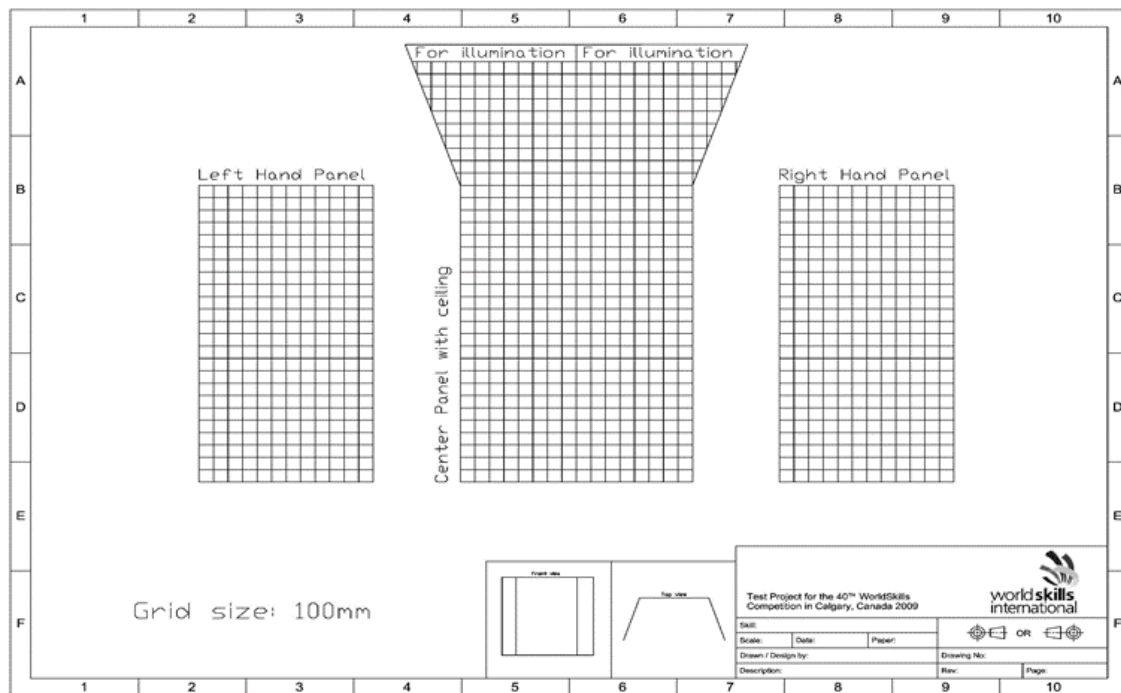


### Competition Organizer requirements

- Ensure a power supply of 230 V AC or 110 V AC at each workstation;
- Ensure that necessary power supplies are available for testing;
- Will build module one of the Test Project to ensure that all materials are sufficient and have this completed project on display in the Competitors area of the competition floor.

### Panel layout

The layout of the work cubicle shown below is just for reference purposes.



## 5.4 TEST PROJECT DEVELOPMENT

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

### 5.4.1 Who develops the Test Project or modules

The design team will comprise of:

- Chief Expert;
- Deputy Chief Expert;
- Six other Experts who are selected by vote at the previous Competition.

All Experts can submit proposals to the design team and the Expert must receive feedback from the design team.

The design of the project is not to be influenced in anyway way by the sponsors for this Skill.

### 5.4.2 How and where is the Test Project or modules developed

The Test Projects modules are independently designed by Experts and submitted to the design team.



### 5.4.3 When is the Test Project developed

The Test Project is developed according to the following timeline:

TIME	ACTIVITY
At the previous Competition	Experts selected for the design team. Design team with the Chief Expert will be responsible for developing the modules. Elected design teams for 2015 are: Module 1: CH, DE, AE, AT, KR, JP, AU, NO, CN, KW Module 2: FR, BR, ID, MY, HU Module 3: JP, CN, ID, SA, CA, TW, IS
Three (3) months after the previous Competition	Experts submit module proposals to design team with drawings and/or written descriptions
Six (6) months after previous Competition	All necessary drawings and instructions for each module are presented to the Workshop Manager for the current Competition
Nine (9) months after the previous Competition	Final drawings, instructions and marking schemes are agreed for each module
Nine (9) months prior to the current Competition	Chief Expert is to ensure that: The circuit designs are accurate All installation requirements can be completed Each module can be completed within the allocated time Proper function is achievable Infrastructure List is accurate and matches the test project Coordination with Workshop Manager is carried out Competitor instructions are kept to a minimum text, and they do not exceed the space permitted on the instruction sheets for any one module The Test Project is complete in all aspects A complete marking scheme has been developed that provides accurate and fair criteria to assess each module Final changes to the Test Project, if required
At least Five (5) months prior to the competition	Test Project is circulated. Photographs or catalogues of the different devices and methods of installation used in the Test Project are circulated

## 5.5 TEST PROJECT VALIDATION

The Chief Expert, Deputy Chief Expert and the Workshop Manager will decide together that it is possible for all modules to be completed. Time, Competitor skill and materials will be taken into consideration. The Competition Organizer will build the Test Project and have it displayed at the competition site.



## 5.6 TEST PROJECT SELECTION

By the design team, the Chief Expert and the Deputy Chief Expert.

## 5.7 TEST PROJECT CIRCULATION

The Test Project is circulated via the website as follows:

At least five months before the current Competition. Refer to table in 5.4.3.

## 5.8 TEST PROJECT COORDINATION (PREPARATION FOR COMPETITION)

Coordination of the Test Project will be undertaken by the Chief Expert.

## 5.9 TEST PROJECT CHANGE AT THE COMPETITION

At the Competition the Experts must bring a proposal for the function, programming and installation testing faults.

One of each will be chosen randomly by the skill management team. The Chief Expert and Deputy Chief Expert will ensure that the proposal meets the requirements of the Technical Description.

The 30% change will be limited to changes in the function, programming and installation testing faults.

## 5.10 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](http://www.worldskills.org/infrastructure) located in the Expert Centre.

If specific material or manufacturer specifications are required to allow the Competitor to complete the Test Project it will be provided along with the Test Project when it is circulated at least five months prior to the Competition. If necessary the WM will arrange a demonstration on site during Familiarization Day.

The materials chosen for modules that are to be built by Competitors, except where the materials are to be supplied by the Competitor, should be of a type available from a number of manufacturers and readily obtainable from suppliers in the Competition Organizer.



## 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 skill specific Discussion Forum (<http://forums.worldskills.org>). 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 the moderator for this Forum. Refer to 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](http://www.worldskills.org/competitorcentre)).

This information includes:

- Competition Rules
- Technical Descriptions
- Marking Schemes
- Test Projects
- Infrastructure List
- Health and Safety documentation
- Other Competition-related information

### 6.3 TEST PROJECTS [AND MARKING SCHEMES]

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

### 6.4 DAY-TO-DAY MANAGEMENT

The day-to-day management of the skill during the Competition 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 finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre ([www.worldskills.org/expertcentre](http://www.worldskills.org/expertcentre)).



## 7 SKILL-SPECIFIC SAFETY REQUIREMENTS

Refer to Host Country/Region Health and Safety documentation for Host Country/Region regulations.

During the Competition Competitors MUST wear ear protection and eye protection at all times.

All marking points regarding health and safety marks will be made clear to all Competitors at familiarization.

If the supervising Experts, who are watching the Competitors, witness any breach of the Health and Safety requirements during the Competition they will:

- On the first occasion: Warn the Competitor and make a note of the breach;
- On the second occasion: Warn the Competitor and make a note of the breach;
- On the third occasion: A record of the breach will be made and result in a loss of the Health and Safety mark;

The Competitor can receive power from the commissioning Expert's team when:

- All mandatory tests have been completed;
- Test Report is submitted and results are correct according to "General instructions for all modules";
- All device covers have been installed;
- No exposed or un-terminated conductors or cables are seen.

Experts will maintain supervision from outside the Competitors marked workstation during the period that the installation is live to ensure safety. The Expert cannot enter the workstation unless the Competitor requests their assistance or if it is deemed that the Competitors' immediate safety is at risk.



## 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](http://www.worldskills.org/infrastructure).

The Infrastructure List specifies the items and quantities requested by the Experts for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Items supplied by the Competition Organizer 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.

### 8.2 MATERIALS, EQUIPMENT AND TOOLS SUPPLIED BY COMPETITORS IN THEIR TOOLBOX

Competitors must bring their own tools, excluding drop saws. All equipment (including electrical appliances) that has not been explicitly forbidden is allowed.

Handheld jigsaws are allowed.

### 8.3 MATERIALS, EQUIPMENT AND TOOLS SUPPLIED BY EXPERTS

Not applicable.

### 8.4 MATERIALS AND EQUIPMENT PROHIBITED IN THE SKILL AREA

Materials and tools according to the Host Country Health and Safety regulations are not allowed.

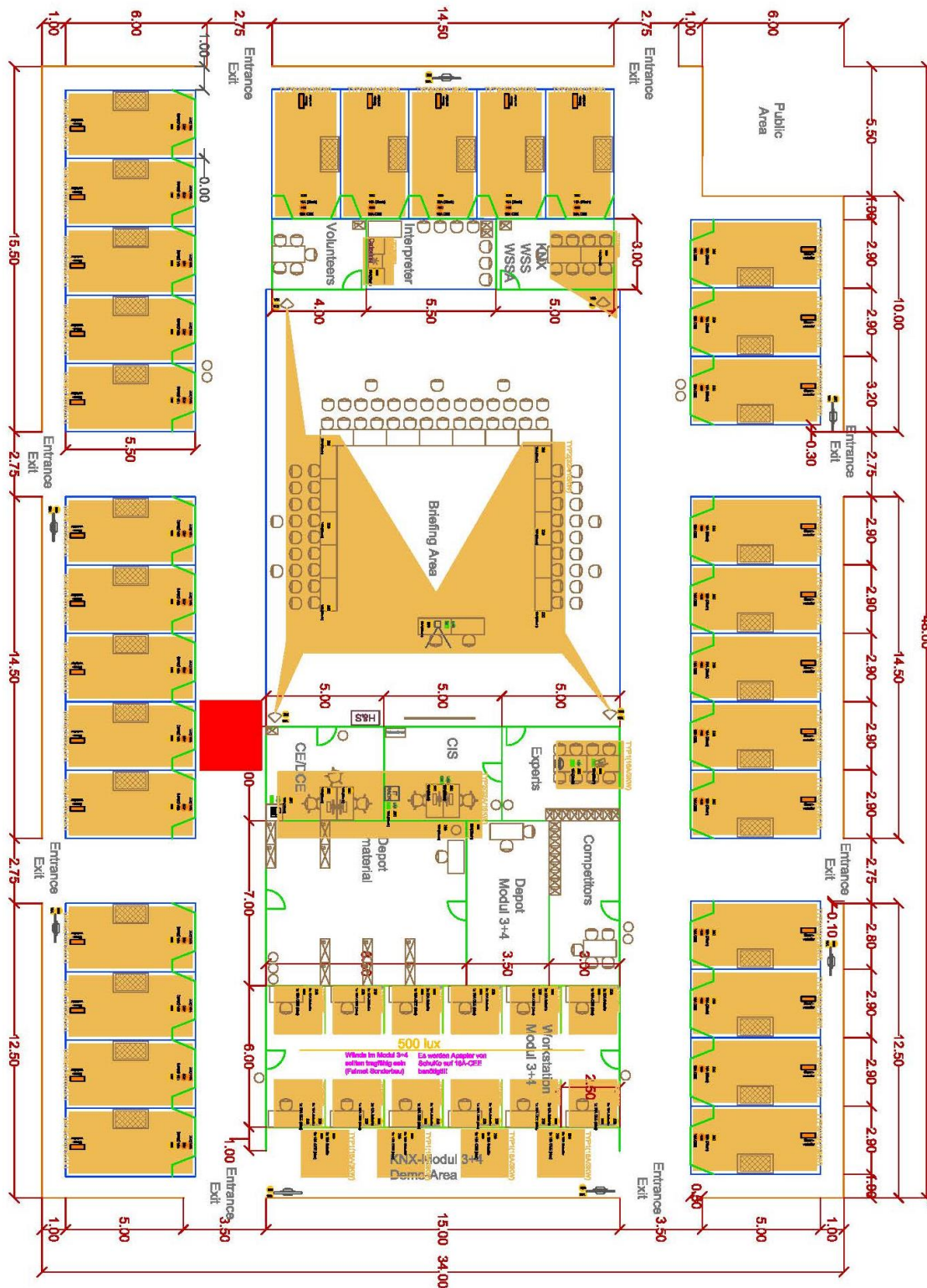




## 8.5 PROPOSED WORKSHOP AND WORKSTATION LAYOUTS

Workshop layouts from previous competitions are available at [www.worldskills.org/sitelayout](http://www.worldskills.org/sitelayout).

Example workshop layout:





## 9 VISITOR AND MEDIA ENGAGEMENT

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

- Try a trade;
- An area next to the competition site, supervised by local apprentices, where young people can try some of the things an electrician work with on a daily basis;
- Display screens;
- Test Project descriptions;
- Drawings and Test Projects/parts of Test Projects may be displayed next to the “try a trade” area.
- Enhanced understanding of Competitor activity;
- Competitor profiles;
- Competitor profiles may be displayed on screens close to the competition site. Useful information is:
  - Name,
  - Age,
  - Country of origin,
  - Type of education,
  - Type of actual career,
  - Information about the Competitors’ choice of apprenticeship;
- Career opportunities;
- Information may consist of:
  - Brochures,
  - Flyers,
  - Informers (young apprentices);
- Daily reporting of competition status;

Daily reporting may be used if all Competitors working on the same module on the same day.



## 10 SUSTAINABILITY

- Recycling;
- Spare materials, are to be offered to local schools to be used in education for training purposes;
- Use of 'green' materials;
- During designing of Test Projects and liaising with the current Workshop Manager, the uses of "green" materials are to be considered. Materials that meet the following requirements are to be used as far as possible:
  - Halogen free,
  - Recyclable,
  - Free from toxic substances.
- Use of completed Test Projects after Competition;
- Materials that can be reused, are to be offered to local schools to be used in education for training purpose. Materials that cannot be reused are to be sorted as per host country regulations or, if meeting higher requirements, WorldSkills regulations;
- Experts and Competitors must take special consideration when designing and packing their tool box for the competition. They must ensure they only pack the minimum amount of tools needed to complete the competition;
- The tool box size will be limited to 0.75 m<sup>3</sup>;
- Project design teams must carefully considered sustainability as a key issue;

All paperwork prepared at the previous competition must be electronically copied by the new Chief and Deputy Chief Expert.