



TECHNICAL DESCRIPTION
Electrical Installations



world **skills**
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:

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Effective 31.03.10



Liam Corcoran
Technical Committee Chair

1. INTRODUCTION

1.1 Name and description of skill

1.1.1 The name of the skill is [Electrical Installations](#).

1.1.2 Description of skill

[The Competition is to reflect the traditional, current and emerging technologies used in the electrical installation contracting industry. The Competitors are to complete Test Projects designed for typical commercial or domestic electrical installations.](#)

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 - Competition Manual
- WSI - Online resources as indicated in this document
- 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

[General electrical installations and maintenance](#)

An electrician must be able to:

- [Demonstrate knowledge of different wiring systems for commercial, domestic and industrial use:](#)
 - [Install cables directly to a surface.](#)
 - [Attach cables to a surface in a secure way.](#)
 - [Maintain even radius bends, without distortion to cable.](#)
 - [Correct termination adaptors used for entry of cables into ducts, boards, equipment boxes etc.](#)
 - [Install single and double insulated cables inside ducts, conduits and flexible conduits.](#)
 - [Install and securely fix double insulated cables onto cable ladder and cable tray.](#)
 - [Install metal and plastic ducting \(trunking\).](#)
 - [Measure and cut duct at specified lengths and specified angles.](#)
 - [Assemble pieces of duct without distortion to joints and to accepted tolerances.](#)
 - [Assemble different termination adaptors, such as glands onto duct.](#)
 - [Attach ducts of different types, in a secure way onto a surface.](#)

- Install metal and plastic conduits
 - Attach conduits onto a surface in a secure way.
 - Maintain even radius bends, without distortion to conduit.
 - Correct termination adaptors used for entry of conduits into boxes, boards, ducts, etc.
- Install metal and plastic flexible conduits
 - Attach flexible conduits onto a surface in a secure way.
 - Maintain even radius bends, without distortion to flexible conduits.
 - Correct termination adaptors used for entry of flexible conduits into boxes, boards, ducts, etc.
- Install cable-ladders, cable-trays etc.
 - Attach different types of cable ladder and cable tray to a surface in a secure way.
- Demonstrate a competent understanding of different types of electrical switchboards used for commercial, domestic and industrial uses:
 - Install electrical switchboards onto a surface in a secure way.
 - Assemble switchboard apparatus (examples listed below), in a switchboard as per given instructions (layout drawings etc).
 - Main switches
 - RCDs
 - MCBs
 - Controlling equipment such as relays, timers, etc.
 - KNX components
 - Fuses
 - Terminate and install wiring inside a switchboard according to circuit drawings.
- Demonstrate a competent understanding of different types of electric lighting and heating systems for commercial, domestic and industrial use.
- Demonstrate a competent understanding of different control devices and socket outlets used for commercial, domestic and industrial uses.
 - Control Device's E.g., Photo Cell, Motion Detector, Thermostats, Switches etc.
 - Outlet E.g., 1 Phase, 3 Phase, etc
 - Install and connect equipment as per instructions provided.
- Demonstrate a competent understanding of different types of telecommunication systems such as:
 - Structured cabling systems (SCS)
 - Fire alarm systems
 - Conventional fire alarm systems
 - Addressable fire alarm systems
 - Evacuation control systems
 - Audio devices
 - Optical devices
 - Control and monitoring systems
 - Burglar alarm systems
 - Conventional burglar alarm systems
 - Addressable burglar alarm systems
 - Access control systems
 - "Stand alone" access control systems
 - "Network supervised" access control systems
 - Closed circuit television systems (CCTV)
 - Cameras, lenses and attachment components
 - Recorders, monitors, etc.
 - Install and construct equipment listed above as per instructions provided

- Select and use appropriate tools.
- Read, interpret and revise drawings and documentation such as:
 - Layout drawings.
 - Circuit drawings.
 - Written instructions.
- Plan, install, test and commission electrical installations in a safe and professional manner.
 - Plan installation work using drawings and documentation provided.
 - Install equipment and wire ways as per drawings and documentation provided.
 - Test installations before energizing to ensure personal and electrical safety :
 - Insulation resistance test.
 - Earth continuity test
 - Test installations when energized:
 - Check complete function on all equipment installed to ensure correct operation of new installation as per instructions provided.
 - Equipment setup:
 - Use the necessary software for programming programmable relays, bus-system, etc.
 - Make necessary settings on devices such as timers, overload relays etc.
 - Program programmable relays
 - Download and import any application required for the product so the specified task can be achieved.
 - Program bus-systems such as KNX, LON or similar.

Faultfinding

An electrician needs to know and understand:

- How to troubleshoot electrical installations and identify faults such as:
 - Short circuits
 - Open circuits
 - Incorrect polarity
 - Insulation resistance faults
 - Earth continuity faults
 - Incorrect settings on equipment
 - Incorrect program on programmable devices
 - Etc.
- How to diagnose electrical installations and identify problems such as:
 - Bad connections
 - Incorrect wiring
 - High fault loop impedance
 - Etc.
- How to use, test and calibrate measuring equipment such as:
 - Insulation resistance testers
 - Continuity testers
 - Installation testers
 - Multi meters
 - Clamp meters
 - Network cable testers
- How to repair faults in electrical installations.
 - Repair faulty components
 - Replace faulty components
 - Rewire faulty installations

Perform all competencies listed above in a professional manner so personal and electrical safety is achieved.

2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.
The theoretical knowledge is limited to that necessary to carry out the practical work: the programming of electronic and electromechanical components (not programmable logic controllers) such as timers, programmable relays and KNX components, reading drawings, sketches and schematic diagrams.

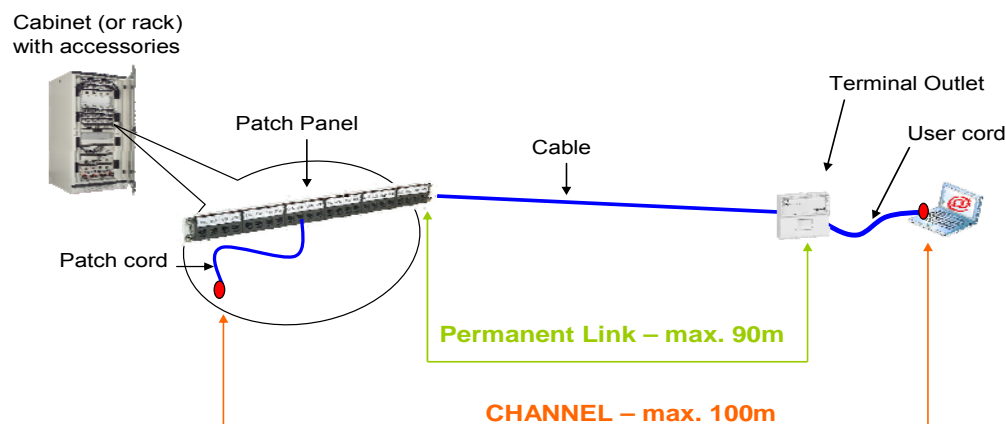
2.2.2 Knowledge of rules and regulations is not examined.

2.3 Practical work

The Competitor must be able to demonstrate a range of skills in the installation of electrical equipment, wiring systems and Structured Cabling Systems (SCS).

The Competitor must be able to carry out all required inspection, testing and commissioning for all relevant modules. When the Test Project is completed, it must be tested by the Competitor and the results submitted in writing.

The following picture illustrates the Permanent link and the Channel.



Refer to : ISO / IEC 11 801

3. THE TEST PROJECT

3.1 Format / structure of the Test Project

The format of the Test Project is a series of standalone modules.

3.2 Test Project design requirements

General requirements

- All technical terms and descriptions used in the Test Project must be in accordance with international standards and terms, if applicable.
- All dimensions must be from specific reference lines (datum 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.
- Any sub-module as listed below must be integrated into the overall function of the installation or module concerned.
- The Test Project may include the following sub-modules and systems:
 - Lighting installation

- Plug socket installation
- Installation of signal/control/power circuits (heat, motors etc. e.g. pump station, boiler control)
- Extra low voltage installation – limited to a maximum of 50 V (AC or DC)
- Wiring and connecting complete channels of cabling infrastructure: User cords, RJ 45 terminal outlets, cables, patch panels and patch cords
- Telephone carrier elements (remote control etc)
- Current and voltage measuring circuits (current transformers and selector switch systems, potential transformers and selector switch systems)
- At least 3 different wiring systems should be used in each module.

The Test Project will consist of the following modules:

Module 1 – Installation Testing

- 1 hour maximum
- Fault finding board to be built by Host Country
- Module and marking to be completed on day C1

Module 2 – Domestic and/or commercial installation using current and developing technology

- 11-hour maximum including programming and commissioning.
- The host country must supply materials for the competition only.
- KNX, LON or equivalent worldwide standardized systems must be used. All devices are to be supplied by the host country. Test project and material list are to be circulated at least 6 months before the beginning of the competition. Competitors are to be provided with descriptions, other necessary documentations and associated product files (product data base). Software is to be chosen by the competitor.
- Competitors are to bring their own laptop.
- Module to begin on day C1 and must be completed by day C2. Marking completed on day C2.

Module 3 – Control circuit installation

- Competitors use circulated instructions to complete the design of the installation using materials from their own country.
- 4.5 hours maximum
- Laptops can be used for programming.
- The program itself is not part of the marking; only requested function will be marked as per instructions circulated.
- Module and marking to be completed on day C3.

Module 4 – Domestic and/or commercial installation using conventional technology

- 5.5 hours maximum
- Using Host Country supplied material
- Drawings to be circulated 6 months prior to the Competition
- Module and marking completed on day C4

General instructions for all modules

Test specifications:

- Insulation resistance – The minimum resistance between any current carrying conductors and any other conductors or earth may not be less than 1 M Ω , tested at a voltage of 500 V DC with an insulation resistance tester.
- 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 Ω .
- Polarity of socket outlets as per Host Country standard.

Instructions for module 1 – Installation testing

- If the Host Country regulations allow “live testing”, this may be allowed.
- The test circuit design 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)
- Types of faults that may be used are:
 - Timer settings
 - Overload settings
 - Short circuit faults
 - Open circuit faults
 - Low insulation resistance
 - High earth resistance
 - High resistance joints
- 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.

Instructions for module 2 – Domestic and/or commercial installation using current and developing technology

- This module may include lighting circuits, power outlet circuits, fixed appliance circuits, Structured Cabling Systems, environment control or access equipment.
- Installation of consumer units and protection equipment should be included.
- Installation and equipment set up of programmable devices should be included.
- Module specific testing of the installation for Module 2 for Structured Cabling System will be to a test performance on the channel (refer IEC 61935-1).
- Inspection, testing and commissioning will be carried out with the test results documented.
- Function testing may be carried out with the installation live at standard mains voltage of the Host Country.
- Manufactured bends are to be used if available in the Host Country.
- No manual bending in this module except offsets if necessary.

Instructions for module 3 – Control circuit installation

- The Competitor is to design a circuit that will satisfy the project specifications using material and equipment from their country of origin using a programmable system.
- The Competitor is to bring with them to the Competition all the equipment necessary to build the project.
- Competitors must bring their own small control system (programmable device) or laptop with appropriate software if required. Software must be readable in at least one of the three WorldSkills Official languages.
- All equipment for this module must be in “as new” condition.
- Pre-programming, pre-wiring, pre-bending, pre-assembly, pre-cutting (specific lengths), etc. is not allowed.
- The control circuit may consist of circuits for heating, cooling, refrigeration or light control.
- Competitors must bring their own transformers if they are necessary for function of the material they bring.

Instructions for module 4 – Domestic and/or commercial installation using conventional technology

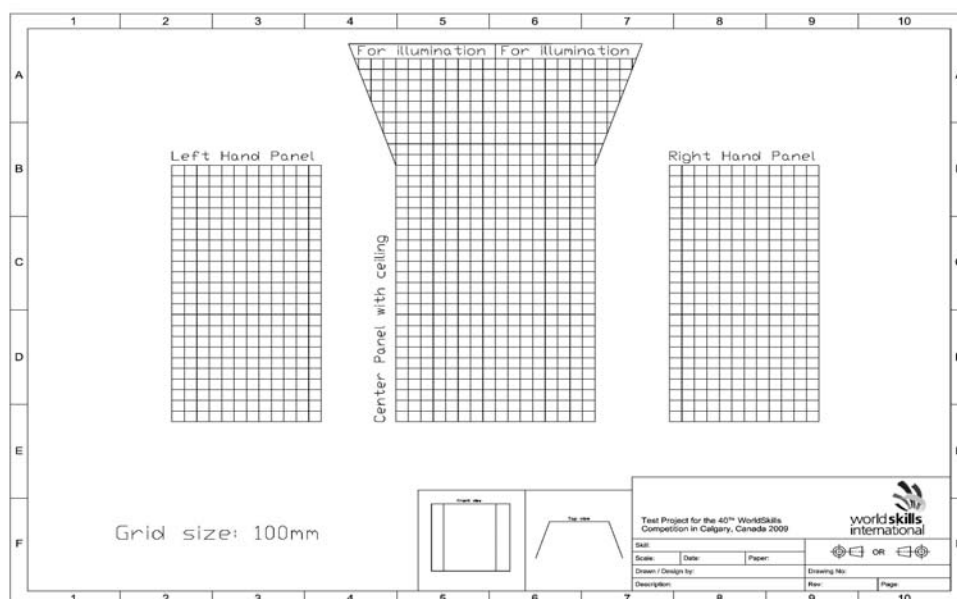
- Installation may include conventional control of lighting circuits and power outlet circuits.
- Manufactured bends are not to be used even in case they are available in the Host Country. Sufficient practice exercise time shall be given to the competitors prior to the competition.
- This module shall include three phase motor control circuit.

Host Country requirements

- Ensure a power supply of 230 V AC and 110 V AC at each workstation.
- Ensure that necessary power supplies are available for testing.

Sample layout

This is a sample layout of the walls and roof to be used to build the cubicles and design the different modules in the test project.



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 a design team comprising the Chief Expert and 4 other Experts selected by vote at the previous Competition. All Experts can submit proposals to the design team.

3.3.2 How and where is the Test Project / modules developed

The Test Project/modules are developed independently by Experts and submitted to the design team.

3.3.3 When is the Test Project developed

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

Time	Task
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 London 2011 are: Module 1 : FI, DE, KR Module 2 : CH, TW, AU, IT Module 3 : JP, AT, NL Module 4 : BR, NO, NZ
3 months after the previous Competition	Experts submit module proposals to design team with drawings and/or written descriptions
6 months after previous Competition	All necessary drawings and instructions for each module are presented to the Workshop Supervisor for the current Competition.
9 months after the previous Competition	Final drawings, instructions and marking schemes are agreed for each module.

Time	Task
9 months prior to the current Competition	<p>Chief Expert is to ensure that:</p> <ul style="list-style-type: none"> • The circuit designs are accurate • All installation requirements can be completed • Each module can be completed within the time constraints • Proper function is achievable • Infrastructure list is accurate • Coordination with Workshop Supervisor 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 identified and required, are completed
6 months prior to the Competition	<p>Test Project is circulated. Photographs or catalogues of the different devices and methods of installation used in the Test Project are circulated.</p>
At the Competition	<p>30% change to modules 2 and 4 are completed by Experts</p>

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 Chief Expert, Deputy Chief Expert and the Workshop Supervisor will decide together that it is possible for all modules to be completed. Time, Competitor skill and materials will be taken into consideration.

3.6 Test Project selection

The Test Project is selected by the design team and the Chief Expert.

3.7 Test Project circulation

The Test Project is circulated 6 months before the current Competition. Refer to table in 3.3.3.

3.8 Test Project coordination (preparation for Competition)

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

3.9 Test Project change at the Competition

At the Competition the Experts make a 30% change to module 2 and module 4 by making any of the following changes:

- Changing measurements
- Changing function.
- Changing materials.

Module 1 faults will be decided at the Competition by the Experts.

When making 30 % change the materials available are to be considered.

Module 3 installation is designed by the Competitor and brought to the Competition so no 30% change is required.

3.10 Material or manufacturer specifications

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 6 months prior to the Competition. If necessary the WSS will arrange a demonstration on site during familiarisation.

The materials chosen for modules that are to be built by Competitors, accept were 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 Host Country.

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 (agreed by Experts and submitted to the Chair/Vice Chair of the Technical Committee). The Chief Expert is to regularly share updates of the Skill Management Plan via the Forum.

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	Safety (electrical and personal)		10	10
B	Commissioning (testing and reporting) and equipment set up and function (programming)		40	40
C	Measurements		10	10
D	Installation of equipment and wire-ways		15	15
E	Wiring and termination		15	15
F	Fault finding		10	10
Total =			100	100

Assessment criteria per module

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

Criteria	Module 1	Module 2	Module 3	Module 4	Total
A	0	5	2	3	10
B	0	15	10	15	40
C	0	5	0	5	10
D	0	8	4	3	15
E	0	7	4	4	15
F	10	0	0	0	10
Total	10	40	20	30	100

Marking allocation

- **Criteria A**
The full marks are awarded for each module and one (1) mark is deducted for each safety breach.

- **Criteria B**
Testing/commissioning/handover
After the competitor has handed the module over for marking, marks will be awarded for
 - Testing the installation and the recording of results prior to safely energising.
 - Equipment setup (programming/setting parameters etc.)
 - Ensure correct operation of all parts of the installation.
 Note 1: No function test will be carried out by experts if the competitor fails to handover the installation for marking.
 Note 2: If function is incorrect, marks will not be awarded for ensuring correct operation and/or equipment setup as defined in the marking scheme
 Function is awarded as marking scheme by experts at the end of each module.

- **Criteria C**
The full marks are awarded for each module and one (1) mark is deducted for each error up to the maximum mark allocation found during marking as defined in the marking scheme.

- Criteria D
The full marks are awarded for each module and one half (0.5) mark is deducted for each error up to the maximum mark allocation found during marking as defined in the marking scheme.
- Criteria E
The full marks are awarded for each module and one (1) mark is deducted for each error up to the maximum mark allocation found during marking as defined in the marking scheme.
- Criteria F
One (1) mark is awarded for every correctly identified and recorded test result presented by the competitor at the end of the module. The competitor must identify the test result of each circuit and the location and nature of any fault found.

5.2 Subjective marking
Not applicable

5.3 Skill assessment specification

The Test Project assessment will focus on the following based on the Criteria:

- A. Personal safety during work and electrical safety on the completed installations on all modules.
- B. Testing and reporting from every module will be assessed as described in the instructions for the various modules. Programming will be assessed in module 2 and 3 considering function.
- C. Measurements and level/plumb will be assessed comparing drawings with the actual installations.

Tolerances	
Level/plumb	bubble on or between lines on level, not outside
Measurements <=500mm	+/- 2mm
Measurements >500mm	+/- 3mm

- D. Installation of equipment may be checked as:
 - Materials and wire-ways secured.
 - No damage on materials, cables, conduits etc.
 - Correct materials and wire-ways installed.
 - Materials and wire-ways assembled and installed.
- E. Wiring and terminations may focus on:
 - No copper visible.
 - No plastic inside the termination.
 - Terminations done correctly (no loose terminations).
- F. Faultfinding will be assessed as faults found or not.

5.4 Skill assessment procedures

The Chief Expert and the Deputy Chief Expert divides the Experts into marking teams. Each team must include at least 1 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.

6. SKILL-SPECIFIC SAFETY REQUIREMENTS

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

The Competitor can get power when pre-commissioning tests are completed, when the commissioning report has been submitted and when the installation is considered safe by the commissioning Expert team.
Experts will maintain supervision of the Competitor during the period that the installation is live to ensure safety.

7. MATERIALS & EQUIPMENT

7.1 Infrastructure List

The Infrastructure List lists all equipment, materials and facilities provided by the Host Country.

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 Host Country will progressively update the Infrastructure List specifying the actual quantity, type, brand/model of the items. Host Country supplied items 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

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

7.3 Materials, equipment and tools supplied by Experts

None

7.4 Materials & equipment prohibited in the skill area

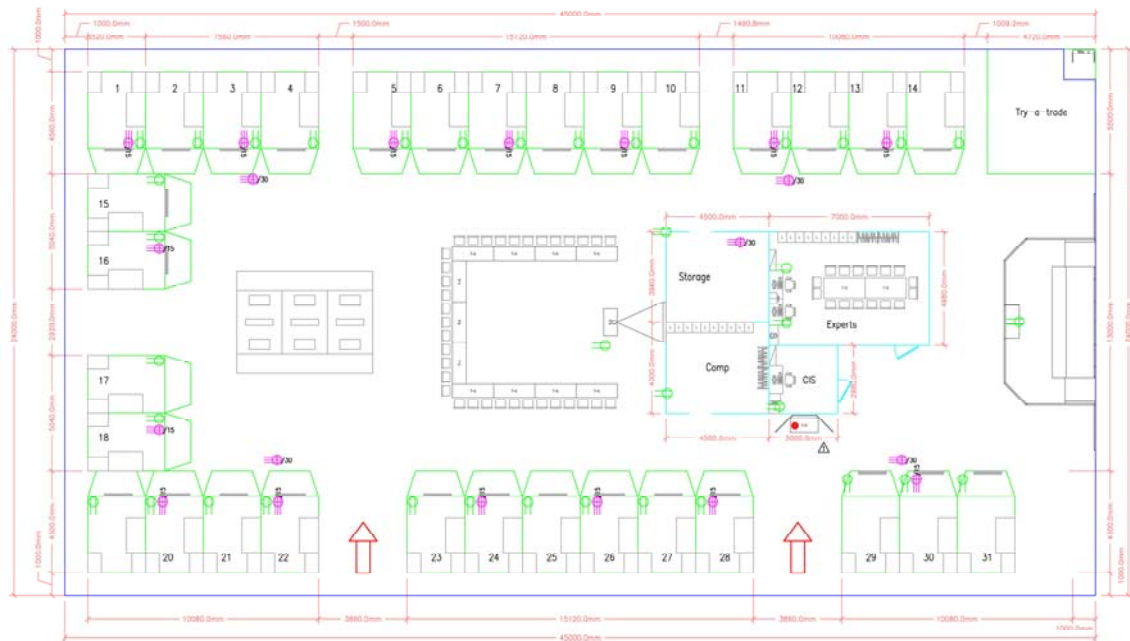
- There are no pre-manufactured materials allowed to be used in Module 3.
- Materials and tools according to the Host Health and Safety regulations are not allowed.

7.5 Sample workshop layouts

Workshop layouts from Calgary are available at:

http://www.worldskills.org/index.php?option=com_halls&Itemid=540

Workshop layout from previous Competition:



8. MARKETING THE SKILL TO VISITORS AND MEDIA

8.1 Maximising visitor and media engagement

Following is a list of possible ways to maximise 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.

8.2 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 Supervisor, 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.

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Technical Committee Chair

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1.1.2 Description of skill

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1.2.1 Every Expert and Competitor must know this Technical Description.

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 - Terminate and install wiring inside a switchboard according to circuit drawings.
- Demonstrate a competent understanding of different types of electric lighting and heating systems for commercial, domestic and industrial use.
- Demonstrate a competent understanding of different control devices and socket outlets used for commercial, domestic and industrial uses.
 - Control Device's E.g., Photo Cell, Motion Detector, Thermostats, Switches etc.
 - Outlet E.g., 1 Phase, 3 Phase, etc
 - Install and connect equipment as per instructions provided.
- Demonstrate a competent understanding of different types of telecommunication systems such as:
 - Structured cabling systems (SCS)
 - Fire alarm systems
 - Conventional fire alarm systems
 - Addressable fire alarm systems
 - Evacuation control systems
 - Audio devices
 - Optical devices
 - Control and monitoring systems
 - Burglar alarm systems
 - Conventional burglar alarm systems
 - Addressable burglar alarm systems
 - Access control systems
 - "Stand alone" access control systems
 - "Network supervised" access control systems
 - Closed circuit television systems (CCTV)
 - Cameras, lenses and attachment components
 - Recorders, monitors, etc.
 - Install and construct equipment listed above as per instructions provided

- Select and use appropriate tools.
- Read, interpret and revise drawings and documentation such as:
 - Layout drawings.
 - Circuit drawings.
 - Written instructions.
- Plan, install, test and commission electrical installations in a safe and professional manner.
 - Plan installation work using drawings and documentation provided.
 - Install equipment and wire ways as per drawings and documentation provided.
 - Test installations before energizing to ensure personal and electrical safety :
 - Insulation resistance test.
 - Earth continuity test
 - Test installations when energized:
 - Check complete function on all equipment installed to ensure correct operation of new installation as per instructions provided.
 - Equipment setup:
 - Use the necessary software for programming programmable relays, bus-system, etc.
 - Make necessary settings on devices such as timers, overload relays etc.
 - Program programmable relays
 - Download and import any application required for the product so the specified task can be achieved.
 - Program bus-systems such as KNX, LON or similar.

Faultfinding

An electrician needs to know and understand:

- How to troubleshoot electrical installations and identify faults such as:
 - Short circuits
 - Open circuits
 - Incorrect polarity
 - Insulation resistance faults
 - Earth continuity faults
 - Incorrect settings on equipment
 - Incorrect program on programmable devices
 - Etc.
- How to diagnose electrical installations and identify problems such as:
 - Bad connections
 - Incorrect wiring
 - High fault loop impedance
 - Etc.
- How to use, test and calibrate measuring equipment such as:
 - Insulation resistance testers
 - Continuity testers
 - Installation testers
 - Multi meters
 - Clamp meters
 - Network cable testers
- How to repair faults in electrical installations.
 - Repair faulty components
 - Replace faulty components
 - Rewire faulty installations

Perform all competencies listed above in a professional manner so personal and electrical safety is achieved.

2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.
The theoretical knowledge is limited to that necessary to carry out the practical work: the programming of electronic and electromechanical components (not programmable logic controllers) such as timers, programmable relays and KNX components, reading drawings, sketches and schematic diagrams.

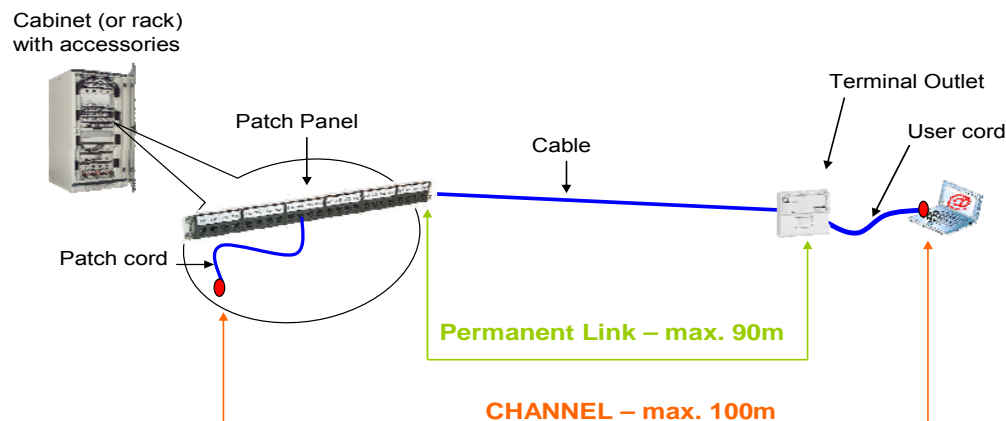
2.2.2 Knowledge of rules and regulations is not examined.

2.3 Practical work

The Competitor must be able to demonstrate a range of skills in the installation of electrical equipment, wiring systems and Structured Cabling Systems (SCS).

The Competitor must be able to carry out all required inspection, testing and commissioning for all relevant modules. When the Test Project is completed, it must be tested by the Competitor and the results submitted in writing.

The following picture illustrates the Permanent link and the Channel.



Refer to : ISO / IEC 11 801

3. THE TEST PROJECT

3.1 Format / structure of the Test Project

The format of the Test Project is a series of standalone modules.

3.2 Test Project design requirements

General requirements

- All technical terms and descriptions used in the Test Project must be in accordance with international standards and terms, if applicable.
- All dimensions must be from specific reference lines (datum 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.
- Any sub-module as listed below must be integrated into the overall function of the installation or module concerned.
- The Test Project may include the following sub-modules and systems:
 - Lighting installation

- Plug socket installation
- Installation of signal/control/power circuits (heat, motors etc. e.g. pump station, boiler control)
- Extra low voltage installation – limited to a maximum of 50 V (AC or DC)
- Wiring and connecting complete channels of cabling infrastructure: User cords, RJ 45 terminal outlets, cables, patch panels and patch cords
- Telephone carrier elements (remote control etc)
- Current and voltage measuring circuits (current transformers and selector switch systems, potential transformers and selector switch systems)
- At least 3 different wiring systems should be used in each module.

The Test Project will consist of the following modules:

Module 1 – Installation Testing

- 1 hour maximum
- Fault finding board to be built by Host Country
- Module and marking to be completed on day C1

Module 2 – Domestic and/or commercial installation using current and developing technology

- 11-hour maximum including programming and commissioning.
- The host country must supply materials for the competition only.
- KNX, LON or equivalent worldwide standardized systems must be used. All devices are to be supplied by the host country. Test project and material list are to be circulated at least 6 months before the beginning of the competition. Competitors are to be provided with descriptions, other necessary documentations and associated product files (product data base). Software is to be chosen by the competitor.
- Competitors are to bring their own laptop.
- Module to begin on day C1 and must be completed by day C2. Marking completed on day C2.

Module 3 – Control circuit installation

- Competitors use circulated instructions to complete the design of the installation using materials from their own country.
- 4.5 hours maximum
- Laptops can be used for programming.
- The program itself is not part of the marking; only requested function will be marked as per instructions circulated.
- Module and marking to be completed on day C3.

Module 4 – Domestic and/or commercial installation using conventional technology

- 5.5 hours maximum
- Using Host Country supplied material
- Drawings to be circulated 6 months prior to the Competition
- Module and marking completed on day C4

General instructions for all modules

Test specifications:

- Insulation resistance – The minimum resistance between any current carrying conductors and any other conductors or earth may not be less than 1 M Ω , tested at a voltage of 500 V DC with an insulation resistance tester.
- 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 Ω .
- Polarity of socket outlets as per Host Country standard.

Instructions for module 1 – Installation testing

- If the Host Country regulations allow “live testing”, this may be allowed.
- The test circuit design 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)
- Types of faults that may be used are:
 - Timer settings
 - Overload settings
 - Short circuit faults
 - Open circuit faults
 - Low insulation resistance
 - High earth resistance
 - High resistance joints
- 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.

Instructions for module 2 – Domestic and/or commercial installation using current and developing technology

- This module may include lighting circuits, power outlet circuits, fixed appliance circuits, Structured Cabling Systems, environment control or access equipment.
- Installation of consumer units and protection equipment should be included.
- Installation and equipment set up of programmable devices should be included.
- Module specific testing of the installation for Module 2 for Structured Cabling System will be to a test performance on the channel (refer IEC 61935-1).
- Inspection, testing and commissioning will be carried out with the test results documented.
- Function testing may be carried out with the installation live at standard mains voltage of the Host Country.
- Manufactured bends are to be used if available in the Host Country.
- No manual bending in this module except offsets if necessary.

Instructions for module 3 – Control circuit installation

- The Competitor is to design a circuit that will satisfy the project specifications using material and equipment from their country of origin using a programmable system.
- The Competitor is to bring with them to the Competition all the equipment necessary to build the project.
- Competitors must bring their own small control system (programmable device) or laptop with appropriate software if required. Software must be readable in at least one of the three WorldSkills Official languages.
- All equipment for this module must be in “as new” condition.
- Pre-programming, pre-wiring, pre-bending, pre-assembly, pre-cutting (specific lengths), etc. is not allowed.
- The control circuit may consist of circuits for heating, cooling, refrigeration or light control.
- Competitors must bring their own transformers if they are necessary for function of the material they bring.

Instructions for module 4 – Domestic and/or commercial installation using conventional technology

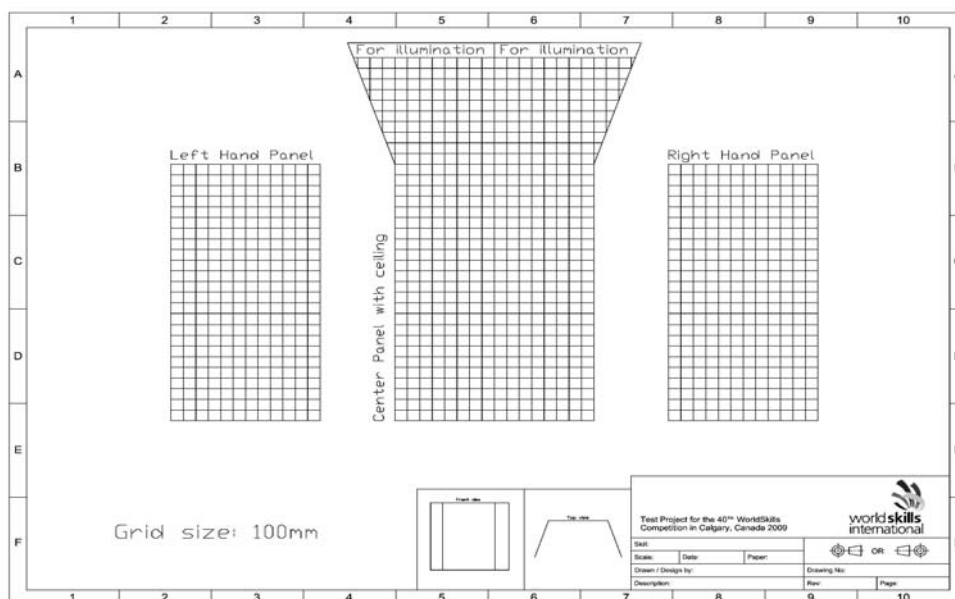
- Installation may include conventional control of lighting circuits and power outlet circuits.
- Manufactured bends are not to be used even in case they are available in the Host Country. Sufficient practice exercise time shall be given to the competitors prior to the competition.
- This module shall include three phase motor control circuit.

Host Country requirements

- Ensure a power supply of 230 V AC and 110 V AC at each workstation.
- Ensure that necessary power supplies are available for testing.

Sample layout

This is a sample layout of the walls and roof to be used to build the cubicles and design the different modules in the test project.



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 a design team comprising the Chief Expert and 4 other Experts selected by vote at the previous Competition. All Experts can submit proposals to the design team.

3.3.2 How and where is the Test Project / modules developed

The Test Project/modules are developed independently by Experts and submitted to the design team.

3.3.3 When is the Test Project developed

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

Time	Task
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 London 2011 are: Module 1 : FI, DE, KR Module 2 : CH, TW, AU, IT Module 3 : JP, AT, NL Module 4 : BR, NO, NZ
3 months after the previous Competition	Experts submit module proposals to design team with drawings and/or written descriptions
6 months after previous Competition	All necessary drawings and instructions for each module are presented to the Workshop Supervisor for the current Competition.
9 months after the previous Competition	Final drawings, instructions and marking schemes are agreed for each module.

Time	Task
9 months prior to the current Competition	<p>Chief Expert is to ensure that:</p> <ul style="list-style-type: none"> • The circuit designs are accurate • All installation requirements can be completed • Each module can be completed within the time constraints • Proper function is achievable • Infrastructure list is accurate • Coordination with Workshop Supervisor 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 identified and required, are completed
6 months prior to the Competition	<p>Test Project is circulated. Photographs or catalogues of the different devices and methods of installation used in the Test Project are circulated.</p>
At the Competition	<p>30% change to modules 2 and 4 are completed by Experts</p>

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 Chief Expert, Deputy Chief Expert and the Workshop Supervisor will decide together that it is possible for all modules to be completed. Time, Competitor skill and materials will be taken into consideration.

3.6 Test Project selection

The Test Project is selected by the design team and the Chief Expert.

3.7 Test Project circulation

The Test Project is circulated 6 months before the current Competition. Refer to table in 3.3.3.

3.8 Test Project coordination (preparation for Competition)

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

3.9 Test Project change at the Competition

At the Competition the Experts make a 30% change to module 2 and module 4 by making any of the following changes:

- Changing measurements
- Changing function.
- Changing materials.

Module 1 faults will be decided at the Competition by the Experts.

When making 30% change the materials available are to be considered.

Module 3 installation is designed by the Competitor and brought to the Competition so no 30% change is required.

3.10 Material or manufacturer specifications

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 6 months prior to the Competition. If necessary the WSS will arrange a demonstration on site during familiarisation.

The materials chosen for modules that are to be built by Competitors, accept were 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 Host Country.

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 (agreed by Experts and submitted to the Chair/Vice Chair of the Technical Committee). The Chief Expert is to regularly share updates of the Skill Management Plan via the Forum.

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	Safety (electrical and personal)		10	10
B	Commissioning (testing and reporting) and equipment set up and function (programming)		40	40
C	Measurements		10	10
D	Installation of equipment and wire-ways		15	15
E	Wiring and termination		15	15
F	Fault finding		10	10
Total =			100	100

Assessment criteria per module

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

Criteria	Module 1	Module 2	Module 3	Module 4	Total
A	0	5	2	3	10
B	0	15	10	15	40
C	0	5	0	5	10
D	0	8	4	3	15
E	0	7	4	4	15
F	10	0	0	0	10
Total	10	40	20	30	100

Marking allocation

- **Criteria A**
The full marks are awarded for each module and one (1) mark is deducted for each safety breach.
- **Criteria B**
Testing/commissioning/handover
After the competitor has handed the module over for marking, marks will be awarded for
 - Testing the installation and the recording of results prior to safely energising.
 - Equipment setup (programming/setting parameters etc.)
 - Ensure correct operation of all parts of the installation.
 Note 1: No function test will be carried out by experts if the competitor fails to handover the installation for marking.
 Note 2: If function is incorrect, marks will not be awarded for ensuring correct operation and/or equipment setup as defined in the marking scheme
 Function is awarded as marking scheme by experts at the end of each module.
- **Criteria C**
The full marks are awarded for each module and one (1) mark is deducted for each error up to the maximum mark allocation found during marking as defined in the marking scheme.

- **Criteria D**
The full marks are awarded for each module and one half (0.5) mark is deducted for each error up to the maximum mark allocation found during marking as defined in the marking scheme.
- **Criteria E**
The full marks are awarded for each module and one (1) mark is deducted for each error up to the maximum mark allocation found during marking as defined in the marking scheme.
- **Criteria F**
One (1) mark is awarded for every correctly identified and recorded test result presented by the competitor at the end of the module. The competitor must identify the test result of each circuit and the location and nature of any fault found.

5.2 Subjective marking
Not applicable

5.3 Skill assessment specification

The Test Project assessment will focus on the following based on the Criteria:

- A. Personal safety during work and electrical safety on the completed installations on all modules.
- B. Testing and reporting from every module will be assessed as described in the instructions for the various modules. Programming will be assessed in module 2 and 3 considering function.
- C. Measurements and level/plumb will be assessed comparing drawings with the actual installations.

Tolerances	
Level/plumb	bubble on or between lines on level, not outside
Measurements <=500mm	+/- 2mm
Measurements >500mm	+/- 3mm

- D. Installation of equipment may be checked as:
 - Materials and wire-ways secured.
 - No damage on materials, cables, conduits etc.
 - Correct materials and wire-ways installed.
 - Materials and wire-ways assembled and installed.
- E. Wiring and terminations may focus on:
 - No copper visible.
 - No plastic inside the termination.
 - Terminations done correctly (no loose terminations).
- F. Faultfinding will be assessed as faults found or not.

5.4 Skill assessment procedures

The Chief Expert and the Deputy Chief Expert divides the Experts into marking teams. Each team must include at least 1 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.

6. SKILL-SPECIFIC SAFETY REQUIREMENTS

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

The Competitor can get power when pre-commissioning tests are completed, when the commissioning report has been submitted and when the installation is considered safe by the commissioning Expert team.

Experts will maintain supervision of the Competitor during the period that the installation is live to ensure safety.

7. MATERIALS & EQUIPMENT

7.1 Infrastructure List

The Infrastructure List lists all equipment, materials and facilities provided by the Host Country.

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 Host Country will progressively update the Infrastructure List specifying the actual quantity, type, brand/model of the items. Host Country supplied items 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

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

7.3 Materials, equipment and tools supplied by Experts

None

7.4 Materials & equipment prohibited in the skill area

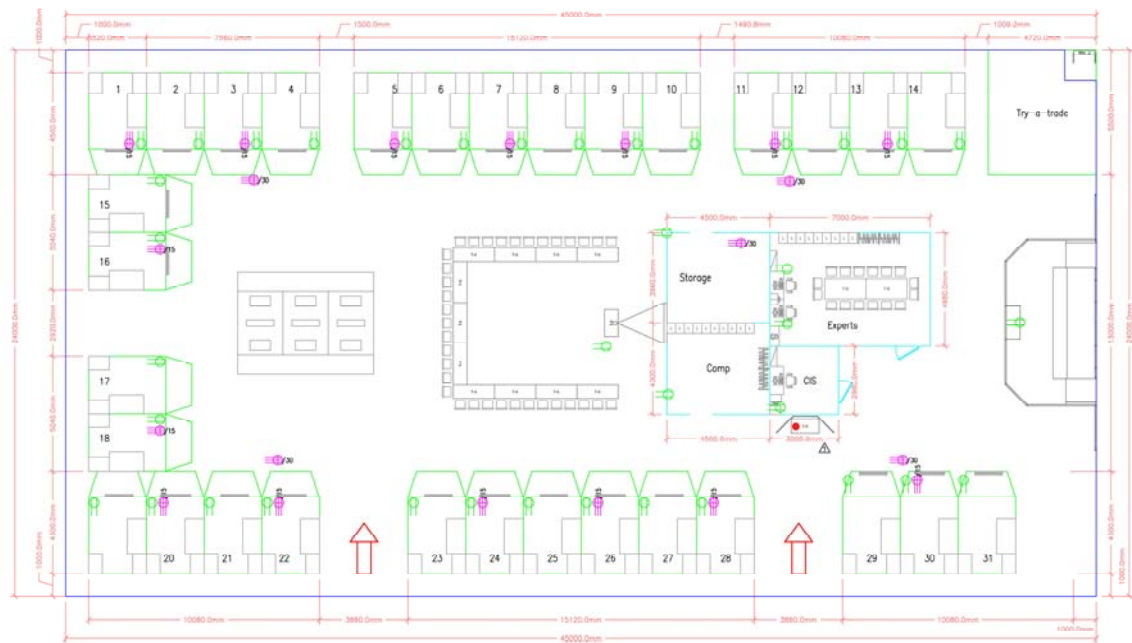
- There are no pre-manufactured materials allowed to be used in Module 3.
- Materials and tools according to the Host Health and Safety regulations are not allowed.

7.5 Sample workshop layouts

Workshop layouts from Calgary are available at:

http://www.worldskills.org/index.php?option=com_halls&Itemid=540

Workshop layout from previous Competition:



8. MARKETING THE SKILL TO VISITORS AND MEDIA

8.1 Maximising visitor and media engagement

Following is a list of possible ways to maximise 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.

8.2 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 Supervisor, 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.