Technical Description
Industrial Control

Skill 19

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

The Technical Description consists of the following:

1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

Industrial Control

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

Industrial Control contains elements of both electrical installations and automation installations, with greater emphasis on automation installation. The industrial control practitioner requires a wide range of technical skills, such as installing conduits, cables, instruments, I/O devices and Programmable Logic Controllers. The industrial control practitioner also designs electrical circuits, programs Programmable Logic Controllers, parametrizes bus systems and configures Human Machine Interfaces.

The working environment is likely to be one that is potentially very dangerous and hazardous. The industrial control practitioner proactively promotes best practices in health and safety and rigorously adheres to health and safety legislation.

Troubleshooting is an important skill of the industrial control practitioner and includes identifying problems during equipment installations in a new plant or remedying problems within an existing plant.

The industrial control practitioner has a wide range of industrial settings in which to work. They may be employed in one particular plant and install and maintain production equipment; or they may be employed by a sub-contractor and work in a number of industrial settings.

Delays in production as a result of reliability issues on the production line can have business implications not only financially but also for the company's reputation. Therefore, the industrial control practitioner needs to work efficiently and effectively to meet time constraints, while also providing expert advice and guidance to management on both technical production issues and on innovative and cost-effective solutions to production problems and requirements. A key skill of the practitioner is troubleshooting, identifying problems during installation, or remedying problems with an established plant.

1.1.3 Number of Competitors per team

Industrial Control is a single Competitor skill competition.

1.1.4 Age limit of Competitors

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

1.2 The relevance and significance of this document

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

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

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

1.3 Associated documents

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

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

2 The WorldSkills Occupational Standards (WSOS)

2.1 General notes on the WSOS

The WSOS specifies the knowledge, understanding, skills, and capabilities that underpin international best practice in technical and vocational performance. These are both specific to an occupational role and also transversal. Together they should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSOS).

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

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

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

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

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

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

2.2 WorldSkills Occupational Standards

Section		Relative importance (%)
1	**Work organization and management**	10
	The individual needs to know and understand: • Health and safety regulations and best practice, especially in relation to hazardous working environments and the variety of locations and industrial settings where the work may be conducted • Safety requirements relating to plant and equipment • SIL levels of safety and the application to relevant industries • The importance of site safety inductions • The range of safety equipment used to protect self and others and the application relating to various industries • The types of hazards that may be encountered in industrial settings	

Section	Relative importance (%)
• The importance of effective communications and interpersonal skills • Principles of sustainable engineering, including energy efficiency, resource conservation, and life cycle thinking. • The importance of reducing environmental impact. • The ability to plan, prioritize, and manage tasks efficiently to meet deadlines and quality standards • Awareness of quality control procedures and the importance of maintaining consistent standards of work	
The individual shall be able to: • Consistently promote and comply with health and safety regulations and industry best practices in all working environments • Correctly use all safety equipment and personal protection equipment (PPE), lock off systems, and warning indicators • Recognize hazards and potentially hazardous situations and take appropriate actions to minimize risk to self and others • Communicate effectively with all relevant professionals, including supervisors, team members, and clients, ensuring clarity during the planning and execution of installations • Think logically and work systematically • Optimizing material usage to minimize waste • Recycling and sorting materials effectively on-site	
2 **Circuit design and modification**	**10**
The individual needs to know and understand: • Principles of technical specification diagrams • Special technical terms and symbols • Interfacing requirements between control circuits and power circuits • Principles of energy-efficient circuit design and sustainable practices • How to apply safety standards in circuit design, including short-circuit protection, and overload protection • The importance of circuit documentation, change tracking, and version control in professional environments • The role of testing, validation, and commissioning in ensuring reliable circuit operation	
The individual shall be able to: • Read and interpret and make additions to technical diagrams in a simulation software according to a function description • Advise on modifications to circuit design • Interpret drawing standard sections (e.g. IEC, DIN, ISO 1219) that are to be used	

Section			Relative importance (%)
		• Implement electrical calculations such as current load, cable sizing, and protection coordination • Ensure compliance with international standards and safety regulations during design • Design electrical circuits.	
3		**Making automation control panels/centres**	**15**
		The individual needs to know and understand: • Terminology and symbols used in technical specifications and diagrams • Principles of technical drawing, circuit diagrams, layouts, function descriptions, and terminal drawings • Uses and layout of operation manuals • Electrical and mechanical tools used in panel building activities, such as drilling and cutting • Lean manufacturing processes (waste etc.) • Responsibility/liability to the customer (extra holes, dirt, damage).	
		The individual shall be able to: • Read, understand, and interpret complex technical drawing, circuit diagrams, layouts, function descriptions, and terminal drawings • Apply information from technical specifications to effective work planning and solutions to engineering and operational problems • Install ducts, terminals, components, and wiring of the control panel according to the drawings and given tolerances • Complete appropriate panel building operations according to specifications • Interpret operations manuals and follow guidelines and instructions.	
4		**Field Installation (electrical and automation)**	**25**
		The individual needs to know and understand: • Issues and challenges of the installation of field components • Principles of technical drawings, layouts of installations and control panels, circuit diagrams, and flow charts • Principles and functions of all components used in field installation • Importance of accurate measuring and calculations during field installations	
		The individual shall be able to: • Measure and calculate the correct positions for the components to be installed • Prepare and install wire trays within given tolerances	

Section		Relative importance (%)
	• Install conduits, cables, devices, instruments, and control centre fittings • Install complex cabling systems that combine power and communications • Plan work effectively to meet time schedule requirements • Use all tools effectively and safely without risk to self or others in the workplace • Test and commission installed equipment • Complete all necessary documentation following installation • Perform basic troubleshooting and rectification of issues encountered during installation and testing	
5	**Programming**	**30**
	The individual needs to know and understand: • Principles of technical specifications and diagrams • Processes of controlling motors, valves, and other devices used in industrial control • HMI and PC-based HMI/Visualization to communicate with the PLC code • Setting of input limits • Uses of industry accepted equipment such as PLC, HMI, VFD/VSD, and distributed IO • Distributed IO based and industrial Bus Technologies • Industry 4.0 technology • IEC sequence-programming methods (IEC 61131-3) • The role of artificial intelligence (AI) and machine learning in enhancing industrial automation systems.	
	The individual shall be able to: • Create programmes according to written specifications and diagrams • Configure HMI-screens according to written specifications and diagrams • Configure HMI-screens to switch automatically to customised start screens • Configure the VSD or Servodrive as required in the function descriptions • Configure VSDs or Servodrives to startup without error messages • Test functions thoroughly and safely • Demonstrate functions to users and provide expert advice and guidance • Conform to IEC sequence programming specifications • Implement reset processes in case of emergency • Interface automation software with artificial intelligence (AI) modules or cloud-based AI platforms, to analyze process and operational data.	

Section		Relative importance (%)
6	**Fault-finding**	**10**
	The individual needs to know and understand: • Safety risks during the fault-finding process • Principles of written specifications, technical drawings, and circuit diagrams • Components and symbols of the relay-based circuit diagrams • Principles of the Relay Control Fault Finding using a multi-meter • Principles and functions of the common Industrial relay/contactor control circuits • Principles and functions of PLC diagnostics • Field Bus Diagnostic principles.	
	The individual shall be able to: • Apply all safety precautions • Read, understand, and interpret complex written specifications and diagrams, understanding all technical symbols • Analyze the correct principles of fault finding • Recognize incorrect principles of fault finding • Utilize the correct fault-finding principles • Utilize a range of tools and software to isolate faults.	
	Total	**100**

3 The Assessment Strategy and Specification

3.1 General guidance

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

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

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

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

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

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

4 Assessment Design and Practice

4.1 General guidance

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

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

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

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

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

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

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

4.2 Assessment Criteria

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

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

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

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

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

4.3 Sub Criteria

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

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

4.4 Aspects

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

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

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

4.5 Assessment and marking

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

4.6 Assessment and marking using Judgement

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

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

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

4.7 Assessment and marking using Measurement

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

4.8 The use of Measurement and Judgement

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

4.9 Skill assessment strategy and procedures

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

Experts use the "Standards and Assessment Guide" throughout the marking process.

This skill includes a 'Fault Finding' module; communication between the Expert and the Competitor is strictly prohibited throughout the competition day, including during breaks and lunch.

Requirements for commissioning and marking

- Installation must meet safety standards before energizing;
- Cable ducts and covers must be securely fixed in place;
- All devices and cables must be identified with labels.

Installation of devices

- Measurement assessment for all Competitors by the water-level supplied by the Competition Organizer for each Competitor, with a minimum accuracy of +/- 0.5 mm/m that must be printed on the water-level;

- Marking will be taken from the edge of the reference line(s), regardless of whether the measurement is made from the top, bottom, left, or right.

Flowchart analysis

- Marking will be done until the first fault. If the fault in a sequence is a signalizing that does not affect the process operation, the next sequence will be tested, skipping the previous fault (the marking will be deducted for this step). If the following sequence cannot be continued, no further functions/steps will be assessed.

Fault finding

- The Competitor is provided with the circuit diagram and may only see the operational circuit before the fault-finding session is started;
- A Competitor cannot return a previous fault (Only one fault at a time is introduced for each test);
- Competitors are permitted to test the circuit in both Power ON and Power OFF states. However, they must request the Expert to perform the switching of the circuit ON and OFF;
- Faults must be introduced in the same order for all Competitors;
- Faults are designed and implemented by the SCM.

PLC programming

- On restart (power OFF/ON), the full system must automatically recover and start without Expert intervention, errors, or interruptions;
- The motor rotation direction (CW and CCW) must be verified by observing the motor axis from the front view (e.g. looking directly at the axis front).

5 The Test Project

5.1 General notes

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

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

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

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

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

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

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

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

5.2 Format/structure of the Test Project

The Test Project is a series of four (4) modules.

The main Test Project is designed and assessed in a modular format. It includes the PLC programming component.

Circuit design and/or modification and fault finding hardware are standalone modules. If a module is completed before the time, the remaining time cannot be transferred to another module.

Module	Name	Approx. hours	Place
A	Main Test Project	12	In the Competitor's booth
B	Programming Test Project	6	In the Competitor's booth with a computer
C	Circuit design and/or modification	1	In the Competitor's booth with a computer

Module	Name	Approx. hours	Place
D	Fault finding hardware	1	In the cabin of the "Fault finding"
	Total	**20**	

Note: Commissioning is embedded in the Main Test Project.

5.3 Test Project design requirements

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

The Test Project must meet the following requirements:

• The Test Project must be modular;
• Be in accordance with the current Technical Description;
• Be a Computer Assisted Drawing (CAD) to ISO-standards supplied in digital format (in AutoCAD .dwg format);
• Contain a standard legend;
• Be self-explanatory, requiring a minimum of translation;
• Include measurements for the installation of materials and equipment from the horizontal and vertical datum (or reference) lines;
• Soft copies of text documents must be provided in Microsoft Word format;
• The Test Project should be constructed from commercially available materials.

Module A - Main Project

Divide into three (3) main elements and split into a master (80-85% till 400V AC and 24V DC) and a slave (15-20% only 24V DC) machine:

1. Installation of devices and wire-ways:

• Measuring and marking of materials and equipment;
• Cutting, drilling, and de-burring operations;
• Assembly and installation of industrial components and equipment;
• Mounting of control panels and electrical devices;
• Working with metal and plastic materials.

2. Installation wiring elements for Power and Control System:

• Installation of wiring and cabling systems for both power and control;
• Termination and connection of wires and cables;
• Mounting, wiring, and I/O termination of PLCs, HMI, and VSD;
• Segregation of power, analog, and digital input/output signals.

3. Testing and commissioning of Wiring and Relay logic:

The following tests and procedures are required for full system commissioning:

- Earth continuity resistance – the maximum resistance between the main incoming earth and any earthed point in the installation must not exceed 0.5 Ohm, tested with a continuity tester featuring a zero-point function;
- Polarity of socket outlets when viewed from the front (looking at the pins) must be:
  ◦ *Single-phase*: clockwise from the earth pin – (L1–N);
  ◦ *Three-phase*: clockwise from the earth pin – (L1–L2–L3–N);
- Polarity check of switches and circuit breakers;
- Live voltage tests – correct voltages must be measured between conductors at any point in the circuit;
- Voltage tests – correct voltages to be measured between conductors at any point in the circuits;
- Safety relay testing and functional verification;
- Fault identification and correction.

Additional requirements:

- All wiring must comply with the project specifications;
- Individual loads used in Test Projects must not exceed 1 kW; the total load must not exceed 2 kW;
- For measurement purposes, one horizontal and one vertical reference line needs to be drawn at the exact center (horizontally and vertically). These reference lines are to be drawn by the Competitors during the Familiarization Day.

Module B – PLC Programming and HMI configuration

All programming and configuration must satisfy the Module B specification.

1. PLC Programming Requirements:

The PLC programme must conform to IEC 1131.3 and be programmed using mostly the following instructions:

- Basic instructions – Bit logic operations, Timer operations, Counter operations, Comparator operations, Math Functions, Conversion operations, Move operations, World logic operations, etc;
- Extended instruction – Date and time-of-day; String + Char, etc;
- Technology – PID Control, Motion Control, etc.

File control – The Competitor will decide on how they will write the program and which of the listed PLC instructions they will use. No other programming methods are to be used that do not respect IEC 1131.3.

2. HMI Configuration Requirements:

- Basic Objects: Texts, labels, Graphic views, Geometric Shapes, etc;
- Elements: I/O fields, Boxes, Buttons, Switches, Bar graph, Slider, etc;
- Controls: Alarms, Trend Control, Monitoring, etc;
- Visual Enhancements: Graphics and Dynamic widgets.

3. VSD/Servodrive Control Requirements:

The VSD/Servodrive is limited to basic control functions using digital and analog signals only.

- Use of basic motion control instructions;
- Competitors must be able to read and write input and output tags associated with the drive.

Module C – Circuit design and/or modification

1. The Competitor is required to design/modify a relay logic, control and/or power circuit diagram in accordance with a specification and/or the functional diagram. The Competitor will design their circuit using FluidSim by FESTO.

2. The design must meet the following requirements:

• Functional requirements being met;
• Economy of design;
• Accurate use of symbols;
• Accuracy of design;
• Provision of a legend.

Module D – Relay logic fault finding – in existing plant (or system)

1. Relay logic fault finding on a given panel:

• The Competitor is required to find five introduced faults within a control and/or power circuit;
• Using a multi-meter, the Competitor must test the panel and identify the faults on the form provided. The form may consist of the circuit diagram, or a function diagram, or a developed form.

2. Design specification for relay logic fault finding:

The test circuit is a normal electrical panel with:

• Timers;
• Switches or pushbuttons;
• Potentiometer;
• Relays;
• Contactors with 2xNO and 2xNC auxiliary contacts;
• Safety relays;
• PID controller;
• Basic VSD;
• Soft starter;
• Simulated loads;
• Lamps;
• Motors.

Faults should be selected from the following list:

• Open circuit (OC);
• Short circuit (SC).

5.4 Test Project coordination and development

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

5.4.1 Test Project coordination (preparation for Competition)

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

5.4.2 Who develops the Test Project/modules

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

The designer of the Test Project must ensure that each module (particularly Module A) can be completed within the competition time. The designer must have participated in at least one previous WorldSkills event, preferably as an Expert, or at a minimum as an observer.

5.4.3 When is the Test Project developed

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

Time	Action
Fifteen (15) months prior to the Competition	The ITPD is identified, and a Confidentiality Agreement between WSI and the ITPD is organized.
Three (3) months prior to the Competition	The Safety Report document template will be circulated via the WorldSkills Discussion Forum for safety reasons. Any special or new programming function that may be needed for completing the Test Project must be communicated via the WorldSkills Discussion Forum.
No later than two (2) months prior to the Competition	The Test Project documents are sent to the WorldSkills International Skills Competitions Administration Manager.
At the Competition at the beginning of each module	The Test Project/modules are presented to the Experts and Competitors.

5.5 Test Project initial review and verification

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

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

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

5.6 Test Project validation

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

5.7 Test Project circulation

The Test Project/modules are not circulated prior to the Competition. The Test Project/modules are presented to Experts and Competitors at the beginning of each module.

5.8 Test Project change

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

5.9 Material or manufacturer specifications

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

Competitor computer specifications:

The Competition Organizer will ensure that Competitor computers/laptops are installed and operating independent to any external network. The programming and configuration software is installed in English and is tested for all communications options required by the Competitors to work with the supplied hardware.

The computer/laptop is of sufficient capacity to run all the programming software simultaneously at an optimal speed. This will require a specification from the software supplier at the time of the competition setup to be met or exceeded.

Computer screen(s) resolution must be 1920 * 1080 and 24" minimum.

Fault finding equipment specifications:

The Competition Organizer will construct sufficient identical test panels for the number of Competitors to complete in one day.

Fault finding panels to be built prior to the Competition.

6 Skill management and communication

6.1 Discussion Forum

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

6.2 Competitor information

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

This information includes:

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

6.3 Test Projects and Marking Schemes

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

6.4 Day-to-day management

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

The maximum active working period without a break is 3 hours for module A (Main Project) and module B (PLC programming).

In the modules that involve programming and circuit design (modules B and C) and fault finding (module D), Competitors are not allowed to go with their compatriot Experts and/or Interpreters during break and lunch periods. If Competitors leave the skill area, they must be supervised by one or more designated persons and must form a group that is not allowed to separate. They must remain together at all times, including while waiting for and using the restroom.

6.5 General best practice procedures

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

Topic/task	Best practice procedure
Test Project	• The fault-finding module is briefly presented by the Skill Competition Manager.
Programming	• All information regarding program function requirements must be provided equally to all Competitors and must be presented in a non-verbal functional format (e.g. diagrams, flowcharts, tables); • An external power supply must be available from the Competition Organization to test communication between the PC and PLC hardware on the Familiarization Day, or the Competitor may bring the PLC hardware with pre-wired wiring before sending it to the competition to save on-site testing time. After successful testing, the pre-wired wiring must be removed by the participant himself at C-2 or by the Expert under supervision at C-1.
Translation	• Generic information without dimensions or other technical information will become a document that can be translated if needed; • Interpreters can translate or check the translation of the Test Project before the Competition begins. • Standard words, values, and configuration symbols, as shown in the used software, must not be translated.
Help/assistance	• For the installation of the main Test Project the Competitor can call in a non-compatriot Expert to help carry a heavy load.
Additional time for Competitors during commissioning	• The Competitor gets 15 minutes out of working hours to complete the Safety Report and ensure that all safety standards for the power are met; • If the Competitor exceeds the 15-minute limit for completing the commissioning, the extra time used will be deducted from their total working time.
Professional Assessment Practice	• Follow the "WorldSkills Standards and Assessment Guide" related to the Industrial Control skill to support assessment of the judgment and measurement.

Topic/task	Best practice procedure
Wiring	• If standard wiring color codes are not available on the competition day, the Experts must select alternative colors for use by the Competitors. A sufficient variety of colors must be provided as required by the Test Project.
Visitors	• Two screens should be turned to the public and visitors during programming, or an additional TV screen per Competitor

7 Skill-specific safety requirements

7.1 Personal Protective Equipment

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

Task	Safety glasses with side protection	Cut protection gloves	Safety shoes with protective cap	Tight fitting work clothes (long trousers and long sleeves)	Hearing protection	Insulated electrician gloves
At the workstation			√	√		
All times other than programming	√		√	√		
When handling materials likely to cause injury	√	√	√	√		
For commissioning	√		√	√		√
When using power tools for cutting	√	√	√	√	√	

8 Materials and equipment

8.1 Infrastructure List

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

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

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

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

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

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

8.2 Competitors toolbox

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

8.3 Materials, equipment, and tools supplied by Competitors

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

However, Competitors are allowed to bring a maximum of five personal HAND TOOLS (crimping, stripping, screwdrivers, bits, hole saw, etc.), whether different or identical, with a maximum of five units in total weight not exceeding 2 kg, on the morning of C-2 (Familiarization Day). Additionally, a wired USB keyboard and mouse, tool belt or vest, pencil case, pens, pencils, mechanical pencil, sharpener, eraser, permanent marker, and highlighters are allowed and are not included in the quantity and weight limitations.

The equipment supplied by SIEMENS (partnership with WorldSkills) is also excluded from this limitation. **Really important regarding SIEMENS devices:** The equipment on loan for training must be brought by the Competitor on C-2 (Familiarization Day), if no new equipment is provided at the competition. The full list of SIEMENS devices will be communicated via the WorldSkills Discussion Forum.

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

It is recommended that these tools and equipment be carried in the luggage of the Competitor or purchased locally.

The table below shows the list of allowed items:

Description	Quantity	Photo
Personal HAND TOOLS with a total weight not exceeding 2 kg (e.g. crimping, stripping, screwdrivers, bits, hole saw, etc.)	5	Example
Wired USB keyboard and mouse	1	
Tool belt or Vest	1	
Pencil case	1	
Mechanical pencils, pencil, pens, sharpener, eraser, permanent marker, and highlighters	As needed	
Personal Protective Equipment as specified in section 7	As needed	
SIEMENS devices - The full list will be communicated via the WorldSkills Discussion Forum	-	

NOTE: According to the Competition Rule (9.7.1). The Competitors are not permitted to use their personal equipment with functionality identical to equipment provided unless it has been agreed

with the Director of Skills Competitions that a duplicate tool can be brought by the Competitor, and it is listed in the Infrastructure List.

8.4 Materials, equipment, and tools supplied by Experts

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

Experts are responsible that Interpreters bring their own PPE.

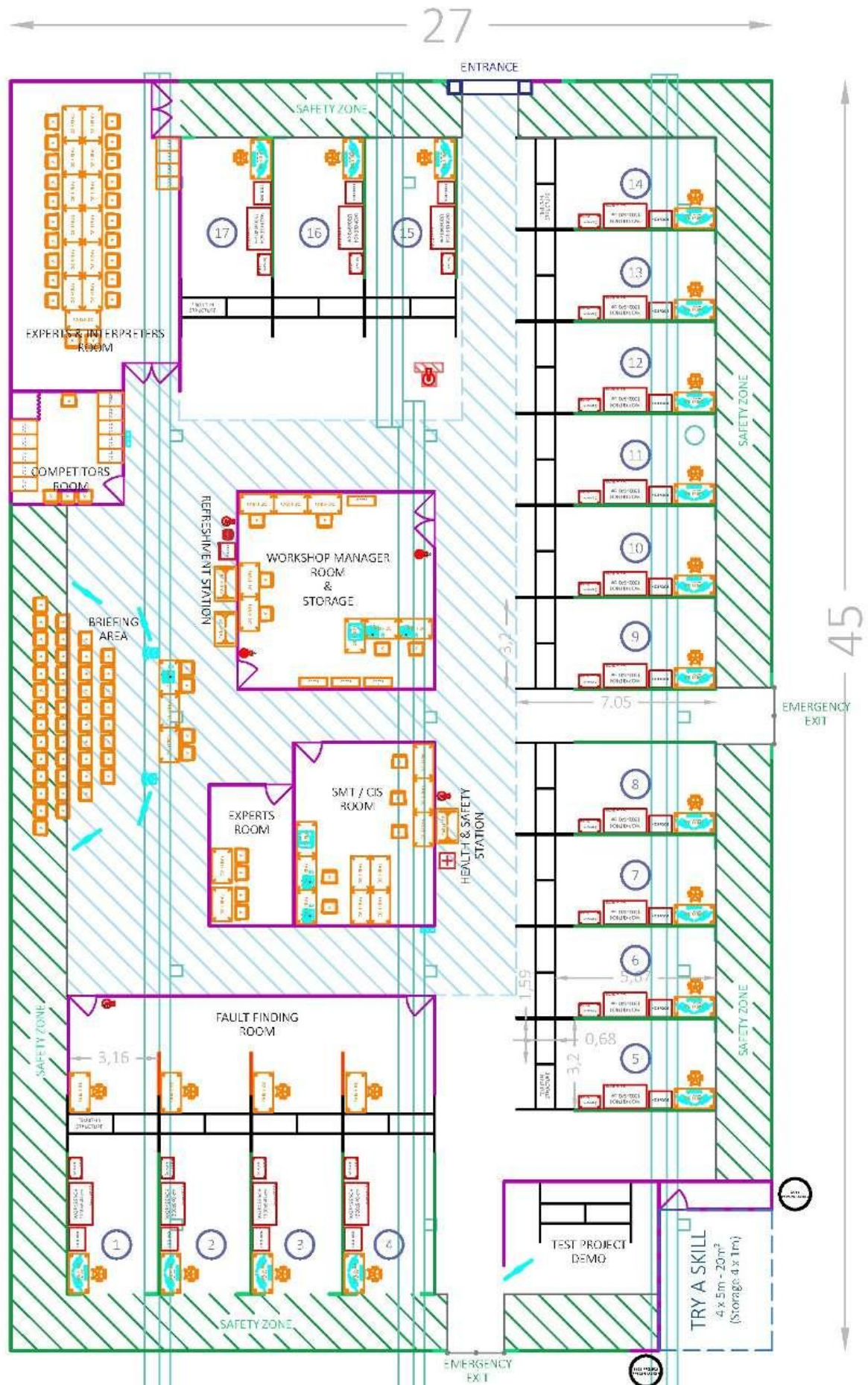## 8.5 Materials and equipment prohibited in the skill area

Competitors and Experts are prohibited to bring any materials or equipment not listed in section 8.3 and section 8.4.
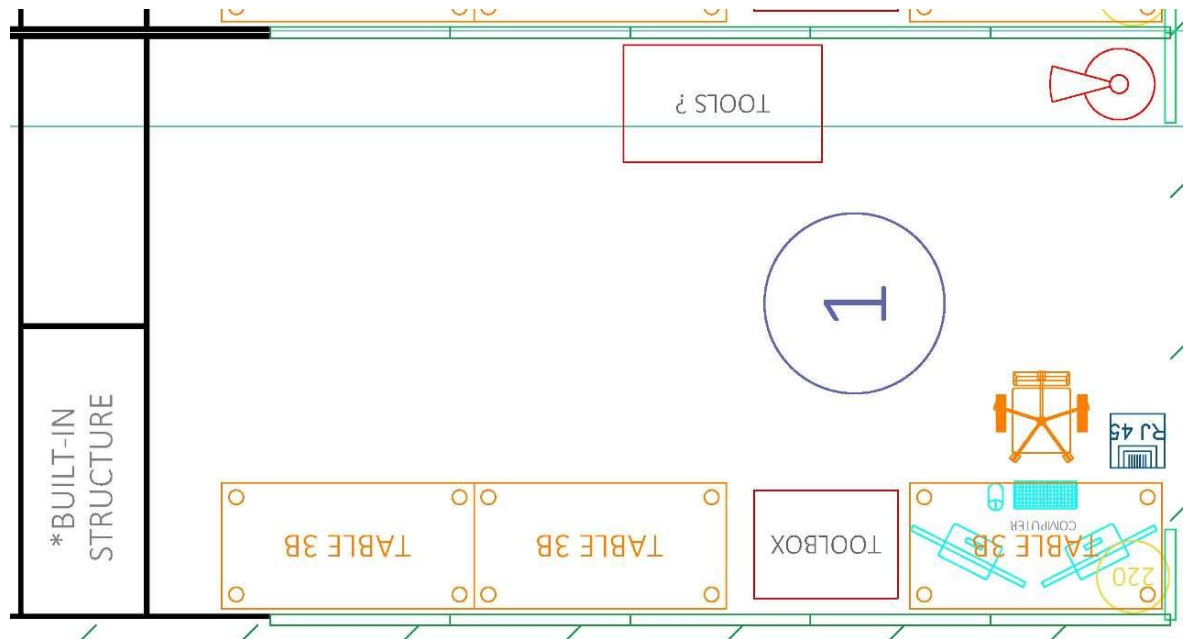
- Preformed templates;
- Mobile phones, watches, and other connected devices for Competitors;
- Memory storage devices for PC or PLC programmes;
- Any documentation other than operating manuals (no project instructions or procedures);
- Keyboard/mouse with special keys, smart or storage card readers, additional USB-Ports or programmable functions;
- Wireless keyboard/mouse.

8.6 Proposed workshop and workstation layouts

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

Example workshop layout

ENTRANCE

SAFETY ZONE

EXPERTS & INTERPRETERS ROOM

COMPETITORS ROOM

REFRESHMENT STATION

WORKSHOP MANAGER ROOM & STORAGE

BRIEFING AREA

EXPERTS ROOM

SMT / CIS ROOM

HEALTH & SAFETY STATION

FAULT FINDING ROOM

SAFETY ZONE

SAFETY ZONE

SAFETY ZONE

SAFETY ZONE

EMERGENCY EXIT

EMERGENCY EXIT

TEST PROJECT DEMO

TRY A SKILL
4 x 5m - 20m²
(Storage 4 x 1m)

45

3,2

7,05

1,59

5,67

0,68

3,2

3,16

*BUILT-IN STRUCTURE

TOOLS ?

1

RJ 45

TABLE 3B

TABLE 3B

TOOLBOX

TABLE 3B

COMPUTER

220

9 Skill-specific rules

9.1 General notes

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

9.2 Skill-specific rules

Topic/task	Skill-specific rules
Documents	• All competition documents must remain in the competition workshop and will be collected each day after official working time; • No document can be taken outside the competition workshop, e.g. notes, planning documents, Test Project documents, etc.
Laptops, mobile phones, smart watches, and other digital devices	• Competitors are not allowed to bring personal laptops, tablets, or mobile phones into the workshop, including other communication devices such as smartwatches. If Competitors do bring these to the competition, they shall be locked in the personal locker and shall not be taken to the workstation. These can only be removed after the module for that day. This rule is valid for C-2 until the end of C4; • Skill Competition Manager, Chief Expert, Experts, and Interpreters are allowed to bring and use personal laptops, tablets, and mobile phones in assigned areas during free time only. During assessment, briefing, preparations, etc. these items cannot be used.
Visibility and presentation	• Competitors can´t cover the Test Project.
Fault-finding hardware	It is not allowed to: • Open the wiring ducts; • Take measurements from fault interrupters; • Force the relay (contactor) when the circuit is energized (power ON).
Procedure for testing PLCs and programming software prior to being used	• Experts (or their nominee) must be sure that PLCs are cleared prior to the Competition start and that the programming software is correctly installed; • Experts (or their nominee) must check that no PLC's program is copied on the Competitor's working PC;

Topic/task	Skill-specific rules
	• A seal must be put on the disk drive and the memory slot of the PLC, if it has one.
Programming	• Competitors are not allowed to help each other during the programming module at the working booths; • The PLC variable table must be provided as an importable file for use starting from module B. This file must be stored on the desktop of the participant's PC. The same requirement applies to HMI images, which must be supplied as a library if they are not already included in the standard HMI library.
Safety rules for SCM, CE, E, and I	• Are required to supply their own Personal Protective Equipment as per section 7 skill-specific safety requirements.
Familarization	• Competitor is allowed to unbox the provided material and get familiar with the type(s). It´s allowed to open the material, BUT strictly prohibited to familiarize oneself with assembling or combining anything. "As it comes out of the box or bag".
Knives	• No allowed breakable blades or without a self-locking mechanism.

10 Expert knowledge and experience

10.1 Requirements

Experts appointed for this skill competition must have the following knowledge and experience for the appropriate occupation or work role as documented in **section 1.1.2**.

Minimum qualification

- Diploma or Bachelor's degree in Electrical Engineering, Mechatronics, Industrial Automation, or a related field;
- Certified training in PLC programming based on IEC 61131-3 standards;
- Certification in software tools such as TIA Portal and FluidSIM is considered relevant;
- Certified training in safety standards for industrial electrical installations.

Expected experience

- Practical industry experience in electrical and automation installations;
- Experience with industrial PLC programming, HMI configuration, and VSD/Servo parameterization in real plant environments;
- Hands-on involvement in circuit design, panel building, and wiring/termination;
- Practical exposure to field installation of control systems, including devices, sensors, actuators, and industrial communication networks;
- Experience in commissioning and testing of electrical installations, including functional tests, insulation resistance, and safety checks;
- Experienced in diagnosing and resolving faults in relay logic and PLC systems through schematic analysis and systematic troubleshooting;
- Familiarity with working in hazardous or high-risk environments, applying best practices in health and safety;
- Experience working with multidisciplinary teams;
- Capable of clearly explaining technical and non-technical information to the entire team.

Specialization

- Flowchart-based logic design for control systems;
- Able to communicate verbally in English for basic technical discussions and workplace coordination;
- Operation and testing of automation devices and machines, including PLCs, HMIs, VFDs, sensors, and actuators.

11 Visitor and media engagement

11.1 Engagement methods

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

- Build a demonstration stand (Try-a-Skill and also used for Mandatory Assessment Training for both Measurement and Judgement, marking training);
- The main Test Project will reflect an automated working plant;
- Each Competitor will construct an active visualization image of the automated plant which is visible to visitors and media;
- All Competitor profiles can be shown on a common screen for visitors and media.

12 Sustainability

12.1 Sustainable practices

This skill competition will focus on the sustainable practices below:

- Recycling;
- Use of "green" materials;
- Use of completed Test Projects after Competition, e.g. try to find a real customer;
- Wires, conduits, consumables, etc. are to be used efficiently.

13 References for industry consultation

13.1 General notes

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

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

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

13.2 References

This WSOS (Section 2) appears to relate most closely to Industrial Engineering Technicians: https://www.onetonline.org/link/summary/17-3026.00

and/or to Industrial Engineering Technician: http://data.europa.eu/esco/occupation/bcc21c63-7eee-4520-8fa7-43eefd389668

and/or or Industrial Electrician: http://data.europa.eu/esco/occupation/5df63943-f1bc-4438-90f1-92768a7a23c8

These links can also be used to explore adjacent occupations.

ILO 7411

The following table indicates which organizations were approached and provided valuable feedback for the Description of the Associated Role and WorldSkills Occupational Standards in place for WorldSkills Shanghai 2026.

Organization	Contact name
Test Fuchs	Ewald Dangle, Apprentice Coordinator
Volvo Group Trucks Technology	Bernardo Nogueira Giarola, Senior Epic Owner Services
VMI security	Victor Antônio Fonseca e Silva, Technical Analyst

14 Appendix

14.1 Appendix information

Not applicable.