

# TECHNICAL DESCRIPTION

## WELDING



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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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## **1. INTRODUCTION**

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

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

1.1.2 Description of skill

[Welders are craftsmen and women who need hands-on skills to do a professional job. Different welding processes are required with different materials. In order to meet the quality requirements, welders must be able to understand welding drawings, standards and markings, apply the required welding processes and understand the characteristics of the materials. Knowledge of welding work safety is also required.](#)

[The skill covers the welding of components, structures, plates, pipes and pressure vessels.](#)

[Standard reference terms and definitions for welding processes, welding positions and weld testing shall be to International Standard Organisation \(ISO\) and American Welding Society \(AWS\) standards. Where a conflict arises, the ISO standards shall have precedence. If no ISO standard is applicable then the relevant AWS standard shall be used.](#)

### **1.2 Scope of application**

1.2.1 Every Expert and Competitor must know this Technical Description.

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

### **1.3 Associated documents**

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

- WSI - Competition Rules
- WSI - Online resources as indicated in this document
- 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**

[Competitors must acquire the knowledge and understanding of the following competencies. Test project modules may include some or all of the below competencies.](#)

#### [Working environment](#)

[Knowledge and understanding of working environment:](#)

- [Comprehend and comply with the standards and laws relating to safety, security and hygiene in the welding and construction industry](#)
- [Describe the various items of personal protective equipment required for any given situation](#)
- [Describe the precautions for the safe use of power tools](#)
- [Describe the possibilities for sustainability in the welding and construction industry](#)

Competitors shall be able to

- Become familiar with the Host Country's Health and Safety Regulations documentation
- Display the safe and proper use of all equipment used in the welding and construction industry
- Identify and use the appropriate personal protective equipment
- Separate trash and different metals for recycling
- Work carefully within their work/competition environment

### Welding

Knowledge and understanding of welding:

- Describe the various welding processes commonly used in industry
- Describe the techniques available for the joining of materials by welding
- Understand basic welding metallurgy
- Describe various methods for the testing welds and welders

Competitors shall be able to:

- Read and interpret drawings and specifications
- Set-up welding equipment in accordance with the manufacturers' specifications
- Select the required welding process as nominated on the drawings
- Set and adjust welding parameters as required, including (but not limited to):
  - Welding polarity
  - Welding amperage
  - Welding voltage
  - Wire feed speed
  - Travel speed
  - Torch/electrode angles
  - Mode of metal transfer
- Maintain welding equipment to deliver required results
- Perform welding in all positions on plate and pipe for all nominated processes as detailed in ISO2553 and AWS A3.0/A2.4
- Weld steel plate and sections utilising the Manual Metal Arc Welding process (111)
- Weld steel plate and sections utilising the Gas Metal Arc Welding process (135)
- Weld steel plate and sections utilising the Flux Cored Arc Welding process (136)
- Weld steel plate and sections utilising the Gas Tungsten Arc Welding process (141)
- Weld stainless steel sheet and sections utilising the Gas Tungsten Arc Welding process (141)
- Weld aluminum sheet and sections utilising the Gas Tungsten Arc Welding process (141)
- Clean welds utilising wire brushes, chisels, scrapers, etc.

### Materials

- Knowledge and understanding of materials:
- Describe the mechanical and chemical properties of steel
- Describe the mechanical and chemical properties of stainless steel
- Describe the mechanical and chemical properties of aluminum
- Describe the properties and classification of welding consumables

Competitors shall be able to:

- Work with the different materials as mentioned above with consideration of the different mechanical and chemical properties. Specific material types include (but are not limited to):
  - Carbon steel
  - 300 series austenitic stainless steel
  - 5000 and 6000 series aluminum
- Check material against supplied Test Project material lists
- Prepare materials for welding
- Select the appropriate filler material type and size for the selected welding process and joint configuration
- Handle/store materials in a manner that will prevent contamination
- Handle/store consumables in a manner that will prevent contamination

## 2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.

2.2.2 Knowledge of rules and regulations is not examined.

## 2.3 Practical work

The Competitor has to be able to carry out, unaided, the following tasks:

Butt and fillet welding of plates, and pipes and rolled metal sections in all working positions and with seams of different angles of inclination and rotation. Welding positions terminology shall be to both ISO2553 and AWS A3.0/A2.4.

- All welding on plate, pipe and pressure vessel to be done in the vertical up progression.
- For the aluminium and stainless steel sheet metal Test Projects modules, all seams shall be done in one run/pass with filler metal.

Plate or pipe	Welding position	Test position AWS	ISO and EN
Plate	Flat	1G, 1F	PA
Plate	Horizontal	2G, 2F	PC, PB
Plate	Vertical up	3G, 3F uphill	PF
Plate	Overhead	4G, 4F	PE, PD
Pipe	Axis vertical, fixed	2G	PC
Pipe	Axis horizontal, fixed	5G uphill	PF
Pipe	Axis @ 45°, fixed	6G uphill	H-L045

The appropriate minimum technical skills are:

- Selecting the most suitable size and type of electrode or filler material.
- Selecting the appropriate current and polarity for the welding process.
- Selecting the appropriate gas pressure, type and rate of flow.
- Adjusting and welding with different modes of metal transfer i.e. short arc, globular, spray arc or pulsed arc.
- Adjusting all welding parameters to give the desired weld type i.e. voltage, wire speed feed, travel speed, welding angles, contact tip to work distance etc

## 3. THE TEST PROJECT

### 3.1 Format / structure of the Test Project

The format of the Test Project is a series of standalone modules and must be validated as defined below.

### 3.2 Test Project design requirements

General Requirements:

Overall, the Test Project shall be modular.

Materials and Equipment:

Welding power sources:

- 111 SMAW, MMAW, 141 GTAW, TIG: AC/DC, 300 Amps Inverter-Type with Hi-Frequency, AC-Frequency (Hz) and Pulse controls
- 135 GMAW, MAG, 136 FCAW: DC, 300 Amps with Pulse control

Welding accessories:

- 111 SMAW, MMAW Welding cable and electrode holder
- 141 GTAW, TIG gun and accessories, contact tips, diffusers, shielding gas accessories, regulator, hoses, remote variable amperage controls, foot- and hand-operated, hose for purging

- 135 GMAW, MAG gun and accessories, contact tips, diffusers, shielding gas accessories, regulator, hoses, etc.
- 136 FCAW gun and accessories, contact tips, diffusers, shielding gas accessories, regulator, hoses, etc.

During the Competition only the materials provided by the Competition Organiser may be used.

Practice plates for the Competition:

The Competition Organiser shall provide 2 sets (4 pieces each) of material for each of the test coupons and 10 pieces each (100x50mm) of aluminium and stainless steel material in the thickness of the tasks, to be used for practice plates. These plates shall be made available to the Competitor for practice on the day set aside for testing the installations before the Competition and for adjusting the welding parameters during the Competition.

Dimensions of practice plates:

The practice plates shall be the same width and thickness as the actual Test Project module pieces but they shall each be shorter by 20mm in length.

Basic materials:

Steel groups according to CR ISO/TR 15608 (1999), Group 1, 2 or 3 for low carbon steel; Group 8 for stainless steel (300 series), and aluminium in the 5000 and 6000 series.

Plates:

- High quality low carbon steel, 2mm to 20mm thick to ISO 10038.
- For pressure vessel, plates are to have through-thickness tested certification.
- Austenitic stainless steel, 1.5mm to 10mm thick e.g. 18/8 types X5CrNi 18
- Aluminium, 1.5mm to 10mm thick e.g. 5000 or 6000 series.

Pipes:

- High quality low carbon steel pipes to ISO 10038, dia. 25mm to 250mm, wall thickness 1.6mm to 10mm
- Stainless steel and aluminium, diameter 25mm to 250mm, wall thickness 1.6mm to 6mm.

Test coupons shall be milled or turned, so that they are smooth and parallel.

### **Module 1: Test coupons**

- Time: 5 or 6 hours approximately.
- Quantity: 3 to 5 specimens, either Single V-groove butt joint welds or fillet welds.
- Processes: See Appendix 9.1.
- Positions: See Appendix 9.1.1
- Drawings: See Appendix 9.2

The Competitor shall submit the test coupons fully assembled to the Experts for stamping prior to welding.

The two fillet weld coupons shall each consist of two (2) pieces each 12mm in thickness, one piece 125mm wide in length and the other 100mm wide, 250mm in length.

Both fillet weld coupons shall have a leg dimension of 10mm, with an allowable tolerance of (+2mm – 0mm) Both fillet welds must be completed with a minimum of 2 runs and a maximum of 3 runs.

One test plate coupon shall consist of two (2) pieces, each 10mm in thickness, 100mm wide and 250mm in length.

The second test plate coupon shall consist of two (2) pieces, each 16mm x 150mm x 350mm.

When welding the 16 mm test coupon, hold point will be as follows:

1. If GMAW (MAG) is drawn for the root pass, a stop/start will be required in the centre 75mm of the plate.
2. If any semi automatic processes (GMAW/MAG), (FCAW/MCAW) are drawn for the fill and cap passes, a stop/start in the centre 75mm of the cap pass only will be required. A weave or the last pass of a multi-pass stringer bead cap is considered for the stop and restart.

GTAW (141) shall not be used on the 16mm test coupon.

GMAW (MAG) is the only semi automatic process to be used for root pass runs. FCAW or MCAW (136) shall not be considered for making root passes.

The pipe test coupon shall consist of two (2) pieces of 114.3mm dia x 8.56mm wall (4" SCH 80) carbon steel pipe.

Each of the two fillet weld coupons shall be welded with a different welding process and shall contain a stop start in the middle 75mm of the test coupon. Whether it is to be located in the root or capping run shall be decided by a jury vote at the Competition. This shall be verified by stamping.

Each of the two plate coupons shall be welded with a different process. If a combination process joint is selected from the table for the 16mm coupon as listed in 9.1 this rule shall not apply.

The pipe coupon shall be welded with the process or processes selected from the table listed in Appendix 9.1.

**HOLD POINT:** All directed stops shall be inspected by an Expert and stamped before restarting.

For all test plates, 20mm at the start and finish shall be discarded for all aspects of inspection and marking.

All butt weld test coupons shall be milled or turned at 30° to a featheredge. (No root face)

See Appendix 9.2 for test coupon drawings.

### **Module 2: Pressure vessel**

Description: A completely enclosed plate/pipe structure, which shall encompass all four of the process types and all weld positions as described in this Technical Description.

- Time: 10 hours approximately.
- Size: Overall dimensional space, approximately 350mm x 350mm x 400mm.
- Plate thickness: 6, 8 and 10mm
- Pipe wall thickness 3 to 10mm
- Pressure test minimum 1000psi (69 bar)

The pressure vessel shall not weigh more than 35kg in the welded condition.

The Experts reserve the right to amend the design test pressure of any pressure vessel prior to the Competition.

### **Module 3: Aluminium structure**

Description: A partially enclosed structure of aluminium, which shall be welded with TIG (141).

- Time: 2 or 3 hours approximately.
- Size: Overall dimensional space approximately 200mm x 200mm x 250mm
- Aluminium plate/pipe material thickness 1.5 to 3mm

All seams shall be done in one run/pass with filler metal.

This Test Project module shall be sawed in half, if necessary, to enable weld penetration inspection and marking.

#### **Module 4: Stainless Steel structure**

Description: A partially enclosed structure of stainless, which shall be welded with TIG (141).

- Time: 2 or 3 hours approximately.
- Size: Overall dimensional space approximately 150mm x 150mm x 200mm
- Stainless steel plate/pipe material thickness 1.5 to 3mm

All root passes of butt joints and corner joints shall be purged with Argon.

All seams shall be done in one run/pass with filler metal.

This Test Project module shall be sawed in half, if necessary, to enable weld penetration inspection and marking.

#### **Competition specific instructions**

Welding machines, tools and equipment usage:

- It is a requirement that the Competition Organiser supplies welding machines that can be used in basic modes of operation.
- Welding machines may be used to their full technical potential.
- It is a requirement that the Competition Organiser provides detailed operation manuals to all participating countries/regions at least six (6) months prior to the Competition.
- The welding machines provided shall have the capability to be operated using both standard amperage control and remote amperage control. Remote variable amperage devices shall be made available and include hand-held and foot controls.

Grinding and the use of abrasive materials and equipment:

- Material removal is not permitted on any of the root penetration or cap weld surfaces. "Cap pass" shall be defined as the final layer of the weld that meets the weld size, grooves and fillets. Restarts may be prepared before welding over them.
- Grinding the surfaces of the fillet coupon material before welding is permitted but the machined preparation angle shall remain at 90 degrees.

Wire brushing:

- Wire brushing, manual or powered, may be used on all weld surfaces of the test plates/pipes (Module 1) and pressure vessel (Module 2). However, wire brushing is not permitted on any of the cap welds of aluminium project (Module 3) and the stainless steel project (Module 4).

Backing bars / plates and restraining devices:

- No copper (Cu) chill plates or ceramic backing tapes/bars are to be used in the Competition.
- Purging equipment may only be used with the Gas Tungsten Arc Welding process on the stainless steel project.
- Restraining devices shall not be used during welding of the test plates. Such devices include: clamps, jigs, fixtures or steel plates, tack welded to the test plates.
- Welding of the test plates is to be carried out without the aid of restraining devices; this is so the Experts can assess the control of distortion.
- Only standard manipulators (positioners), supplied by the Competition Organiser may be used for the welding of the test coupons. Depending on the selected projects they shall at all times be welded and ground 100% on the workbench. The use of jigs, fixtures or standard manipulators is not allowed.

Weld cleaning of GTAW (TIG) projects:

- The weld faces on the aluminium and stainless steel GTAW (TIG) projects are to be presented in the "as welded" condition. Cleaning, grinding, steel wool, wire brushing or chemical cleaning is NOT permitted on any of the cap welds.



**Tack welds:**

- Tack welds shall be maximum 15mm in length. Tacking of the fillet coupons is as follows:
  - One 25mm tack weld placed within the centre 50mm of the coupon to the rear of the weld area and one tack at each end of the test coupon.
- For pressure vessel tacking, 15mm tacks may be combined about the X, Y and Z axis.
- When assembling the pressure vessel, the Competitor may use any of the welding processes listed on that drawing for tack welding, in any position.
- No tack welds shall be made on the inside of the pressure vessel project.
- All tasks are to be fully assembled prior to submission for stamping.
- **HOLD POINT:** An Expert shall inspect the inside of the vessel to ensure the lack of tacks before enclosing the vessel. This is to be confirmed by stamping.
- When tacking the test coupons, i.e. fillet welds, test pipe, and test plates, the Competitor may use any of the welding processes to be used in the Competition.

**Welding of test plates/pipes:**

- Once welding has commenced, the test plates may not be separated and then re-tacked. Re-tacking may only take place, if root welding has not commenced.

**HOLD POINT:** A, Expert shall inspect the positioning of the test pipe coupon in the coupon holder and mark the 12 o'clock position before welding commences. This is to be confirmed by stamping and will also act as a reference point if bend test coupons are to be taken.

If any Competitor welds a coupon with the incorrect process or in the incorrect position, an assessment shall not be carried out and no marks are awarded to that coupon. This will include visual and either fillet break, bends or radiograph.

If any of the joint configurations on the pressure vessel i.e. butt, fillet or outside corners are welded with the incorrect process or in the incorrect position, that joint configuration shall not be visually assessed and no marks are awarded.

If the aluminium or stainless steel structures are welded in the incorrect position, visual assessment shall not be carried out and no marks are awarded.

### 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.

Time	Activity
At the previous Competition	<p>Experts develop and propose Test Project modules.</p> <p>A panel of Experts validates each proposal and a vote for modules 2-4 is conducted for the selection of the modules to be used at the following Competition.</p> <p>Experts indicate their preferred test coupon for the following Competition. The preferred coupons are listed as possible coupons for the following Competition.</p>
Immediately after the previous Competition	The selected Test Project modules 2-4 will be circulated immediately after the previous Competition.
At the Competition	<p>Test coupons (module 1) are selected at random from the list in Appendix 9 and Competitors are notified immediately on Familiarisation Day (C-2).</p> <p>Experts select the position and process for root pass, fill and cap passes. This constitutes the 30% change.</p>

3.3.1 Who develops the Test Project / modules

The Test Project/modules are developed by all Experts (submission is optional for first-time Experts).

3.3.2 How and where is the Test Project / modules developed

The Test Project/modules are developed independently, however, discussion, collaboration and communication is encouraged through the forum.

3.3.3 When is the Test Project developed

The Test Project/modules are developed at the previous Competition.

**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 marking scheme is developed using the marking scheme from the previous Competition and agreed to by vote of the Experts on the forum.

3.4.2 Marking schemes should be entered into the CIS prior to the Competition.

**3.5 Test Project validation**

It must be demonstrated that the Test Project/modules can be completed within the material, equipment, knowledge and time constraints. This will be demonstrated by including the following information with submissions for any Test Project module for selection:

- A separate cutting list for all the required materials for the Test Project modules shall be included to assist the Competition Organisers.
- A photograph of the welded stainless steel and aluminium structures.
- A photograph of the pressure vessel under pressure test with the pressure attained visible, 1000psi (69 bar).

Additional instructions for Competitors to aid in the completion of the project.

**3.6 Test Project selection**

The Test Project is selected as follows:

The Test Coupons for the Competition shall be selected from a standard list at Appendix 9.1. This standard list will detail the position of the coupon, the process for the root pass and the process for the fill and cap passes. Each Expert present at the preceding Competition shall nominate one test coupon of their preference from the standard list, and that coupon will then be eligible for selection at the next Competition.

All Test Project modules shall comply with the Technical Description. An Expert panel will validate each project submitted for selection prior to voting using the following project checklist.

Project submission is optional for first-time Experts.

### Welding Project Selection Criteria

Submitted by: _____ NAME COUNTRY	Pressure Vessel	Aluminium Structure	Stainless Steel Structure
Requirement	Yes/No	Yes/No	Yes/No
Project Drawings ISO A Weld symbols as per AWS Electronic format			
Project Drawings ISO E Weld symbols as per ISO 2533 Electronic Format			
Material/Cutting list			
Photograph of completed tasks			
Pressure Vessel weight		NA	NA
Project Major Dimensions			
Additional instructions on drawings			

#### Module 1 - Test Coupons

The Test Coupons for the Competition will be selected from the standard list at Appendix 9.1 by ballot.

Those coupons nominated at the preceding Competition will be drawn at random just prior to the Competitor familiarisation period. The Competitors shall be informed of the selection at the earliest opportunity on Familiarisation Day (C-2).

#### Modules 2, 3 & 4 - Pressure Vessel, Aluminium Structure and Stainless Steel Structure

The pressure vessel, aluminium structure and stainless steel structure shall be selected by a vote at the preceding Competition by those Experts who are eligible to vote. Any Expert (except first time Experts) who fails to submit a Test Project module for proposal shall not be eligible to vote on the project selection.

Each module is to be selected individually and not as a complete package.

Time will be made available after the Test Project modules have been validated for selection, for those Experts who have projects to submit, to display the drawings and details of their submissions and to brief the remaining Experts on the details of their projects. The Welding Experts will then review the submissions and those who are eligible to vote will do so under the supervision of the Chief Expert.

The Test Project modules selected shall be submitted without delay to be held by the WorldSkills Technical Director until they are circulated on the WSI website as per paragraph 3.7.

The modules listed below are to be completed in the following order. Test order in module 1 is to be determined before C-2.

- Module 1 - Fillet weld one (Day 1)  
Visual assessment, Destructive testing and Competency and assembly assessment
- Module 1 - Fillet weld two (Day 1)  
Visual assessment, Destructive testing and Competency and assembly assessment.
- Module 1 - 10mm Test plate (Day 1)  
Visual assessment, Non Destructive testing and Competency and assembly assessment.
- Module 1 - 16mm Test Plate (Day 1)  
Visual assessment, Non Destructive testing and Competency and assembly assessment.

- Module 1 - Test Pipe (Day 1-2)  
Visual assessment, Non-destructive testing and Competency and assembly assessment.
- Module 2 - Pressure Vessel (Day 1-3)  
Visual assessment, Pressure test and Competency and assembly assessment.
- Module 3 - Aluminium Structure (Day 3-4)  
Visual assessment and Competency and assembly assessment.
- Module 4 - Stainless Steel Structure (Day 4)  
Visual assessment and Competency and assembly assessment.

### 3.7 Test Project circulation

The drawings and associated information for three modules shall be made available via the WorldSkills International immediately after the previous Competition.

The test coupons nominated for the next Competition shall be made available as part of this Technical Description but the specific selection will not take place until the following Competition.

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

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

### 3.9 Test Project change at the Competition

At the Competition, the Experts shall select the position and process for root pass, fill and cap passes from the standard list at Appendix 9.1. This change to the project shall provide the 30% project design change as required by WorldSkills.

Other changes to the remaining tasks are allowed at the discretion of the Experts if required.

This may include process/weld position changes but no changes to the material to be supplied by the Competition Organiser shall be made.

### 3.10 Material or manufacturer specifications

Specific material and manufacturer specifications are located on the Infrastructure List which is online (<http://www.worldskills.org/infrastructure/>).

## 4. SKILL MANAGEMENT AND COMMUNICATION

### 4.1 Discussion Forum

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

### 4.2 Competitor information

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

This information includes:

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

### 4.3 Test Projects

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

### 4.4 Day-to-day management

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

## 5. ASSESSMENT

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

### 5.1 Assessment criteria

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

Criterion	Name	Sub Criterion	Name	Sub Criterion Marks	Max Marks
<b>A</b>	Visual				<b>50</b>
		A1	Module 1 - Fillet weld one	2	
		A2	Module 1 - Fillet weld two	2	
		A3	Module 1 - 10mm Test coupon	2	
		A4	Module 1 - 16mm Test coupon	2	
		A5	Module 1 - Test Pipe coupon	2	
		A6	Module 2 - Pressure vessel	20	
		A7	Module 3 - Aluminium structure	10	
		A8	Module 4 - Stainless steel structure	10	
<b>B</b>	Pressure Test				<b>15</b>
		B1	Module 2 - Pressure Vessel – pressure test	15	
<b>C</b>	Destructive and Non-destructive Testing				<b>25</b>
		C1	Module 1 - Fillet weld one – fillet break test	2.5	
		C2	Module 1 - Fillet weld two – fillet break test	2.5	
		C3	Module 1 - 10mm coupon – face/root bend test	5	
		C4	Module 1 - 16mm coupon – side bend test	5	
		C5	Module 1 – test pipe coupon – NDT test	10	
<b>D</b>	Assembly and Competency Interpretation				<b>10</b>
		D1	All modules – Assembly and competency interpretation	10	
TOTAL MARKS =				<b>100</b>	

*Note: A Competitor cannot have marks deducted for the same imperfection more than once.*

### 5.2 Subjective marking

Not applicable

### 5.3 Skill assessment specification

The skill assessment criteria are clear concise Aspect specifications which explain exactly how and why a particular mark is awarded. The following table is a guide to the visual assessment of weld seams.

Imperfection Description	Explanation	Limits for Imperfections
1. Cracks	Is the weld free of all cracks?	Not permitted
2. Weld starts and craters	Are weld bead craters and starts completely filled? (From crown to crater bottom, or crown of stop and crown of restart)	Task 2 (PV) $\leq 1.5\text{mm}$ Task 3 (AL) $\leq 1.0\text{mm}$ Task 4 (SS) $\leq 1.0\text{mm}$
3. Stray Arc Strikes	Are stray arc strikes absent?	Not permitted
4. Slag and Spatter Removed	Is all surface slag and spatter removed from the joint and surrounding area?	Greater than 99% of all slag and spatter to be removed
5. Grinding Marks	Is the weld surface free from grinding or other metal removal on the cap pass (es) and penetration, for the purpose of enhancing the finished weld?	No metal removal permitted from the finished weld
6. Visual Inclusions	Is the weld metal free of short, solid imperfections? (slag, flux, oxide or metallic inclusions)	Task 2 (PV) Incremental marking Max. 2 defects
7. Worm Holes	Is the weld metal free of visual wormholes or cavities? (elongated cavities)	Task 1 (Coupon) - See International Standard ISO 5817
8. Surface or internal Porosity and Gas Pores	Is the weld metal free of porosity?	Task 1 (Coupon) - See International Standard ISO 5817 Task 2 (PV) Incremental marking Max. 2 defects Task 3 (AL) - Incremental marking Max. 2 defects Task 4 (SS) - Incremental marking Max. 2 defects
9. Undercut	Is the weld joint free from undercut?	$\geq 0.5\text{mm}$
10. Overlap (Overroll)	Is the weld joint completely free of overlap (overroll)?	Not permitted
11. Lack of Penetration	Is the joint free from lack of penetration or root fusion?	Task 1 (Coupon)- See International Standard ISO 5817 Task 3 (AL) – Incremental marking Task 4 (SS) - Incremental marking
12. Excessive root concavity (shrinkage groove)	Is the weld penetration free of excessive root concavity “suck back”?	Task 1 - See International Standard ISO 5817
13. Excessive Penetration	Is the joint free of excessive penetration?	Task 1 (Coupon)- $\leq 2.0\text{mm}$ Task 2 (PV)– N/A Task 3 (AL) $\leq 3.0\text{mm}$ Task 4 (SS) $\leq 2.5\text{mm}$
14. Excessive Face Reinforcement (height)	Is the weld joint free of excessive face reinforcement?	Task 1 (Fillet)- $\leq 3.0\text{mm}$ Task 1 (Butt) $\leq 2.5\text{mm}$ Task 2 (PV) $\leq 2.5\text{mm}$ Task 3 (AL) $\leq 1.5\text{mm}$ Task 4 (SS) $\leq 1.5\text{mm}$
15. Incompletely filled groove	Is the butt weld groove completely filled?	Not Permitted
16. Linear Misalignment (high/low)	Is the joint free from linear (high/low) misalignment?	Task 1 - See International Standard ISO 5817 Task 2 (PV) $\leq 1.0\text{mm}$ Task 3 (AL) $\leq 1.0\text{mm}$ Task 4 (SS) $\leq 1.0\text{mm}$
17. Fillet Weld Sizes	Are fillet sizes in accordance with specifications? (Measurement leg length)	Task 1 (Coupon) -0/+2mm Task 2 (PV) -0/+2mm Task 3 (AL) -0/+2mm Task 4 (SS) -0/+1mm
18. Full Radius Contour	Does the joint exhibit a full radius contour = to plate thickness?	Full radius contour

Imperfection Description	Explanation	Limits for Imperfections
19. Excessive Width of Butt Weld Face	Are bead widths uniform and regular? (Measure narrowest portion vs. widest portion)	Task 1 (Coupon) - $\leq 2.0\text{mm}$ Task 2 (PV) - $\leq 2.0\text{mm}$ Task 3 (AL) - $\leq 1.5\text{mm}$ Task 4 (SS) - $\leq 1.0\text{mm}$

## 5.4 Skill assessment procedures

### Procedure for performing non-destructive testing

1. Specified procedures shall be used for all non destructive testing.
2. The welded test coupons shall be radiographed in the as welded condition. (No removal of any excess weld metal.)
3. Radiography of the test coupons shall be performed in accordance with ISO 5817.

### Procedure for performing fracture tests on the Fillet welded coupon

1. Each test piece shall be positioned for breaking in accordance with ISO 9173.
2. Each coupon shall be visually assessed after breaking for lack of fusion and porosity.

### Procedure for the hydrostatic pressure test

1. The Expert, whose Competitor's vessel is being tested, is allowed to witness the test.
2. Fill the vessel with water and ensure that all air is allowed to escape.
3. Plug vessel and pressurise to 2 bar (30psi).
4. Ensure vessel is fully dry on outside.
5. If vessel exhibits a leak – **Score 1 point** and test is complete. (see # 9)
6. If vessel exhibits no leak, continue to pressurise to 35 bar (500psi). Allow 10 seconds to stabilise before inspection commences.
7. Hold for 60 seconds. If a leak is observed – **Score 1 point** and test is complete. (see #9) If no leak is detected increase pressure to 69 bar (1000psi). Hold for 10 seconds to stabilise before inspection commences.
8. Hold for a 60 seconds. If a leak is observed – **Score 7.5 points**. If no leak is observed - **Score 15 points** and test is complete.
9. Drain all water from the vessel.

Note: If a leak is detected, it shall be highlighted with a metal marker.

## 6. SKILL-SPECIFIC SAFETY REQUIREMENTS

Competitors at a minimum shall use during the Competition the following personal protective equipment. All safety equipment must comply with Host Country Health and Safety requirements.

- Safety Glasses
- Cotton drill long sleeve Shirt
- Cotton drill trousers
- Steel toe cap work boots
- Hearing Protection
- Clear face shield (grinding)

## 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 Competition Organiser will progressively update the Infrastructure List specifying the actual quantity, type, brand/model of the items. Competition Organiser 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**

Non-consumable materials, equipment and tools to be supplied by the Competitor.

The Competitor shall bring tools and equipment in a toolbox and is encouraged to bring other new tools and devices that are being used in today's industry.

The following list as a minimum shall be supplied by the Competitor.

- Welding safety glasses
- Grinding goggles
- Welders helmet, speed lenses are permitted
- Safety boots with protective toes
- Ear protection
- Hand angle grinder with guard, maximum 125mm (5inch)
- Wire brush wheels to suit grinder
- Fire retardant clothing
- Chipping hammer (slag hammer)
- Inter-weld run cleaning, blade scrapers
- Chisels
- Scriber
- Files
- Wire brushes
- Hammer
- Weld gauge (fillet gauge)
- Metric steel ruler (tape measure)
- Square
- Chalk/soapstone
- Dividers
- G-clamps and/or c-clamps and quick gripping devices
- Power transformer (if required) and extension leads
- Competitors may use their own SMAW, (MMAW), GTAW (TIG), GMAW (MAG) and FCAW hand pieces/torches, provided the Competitor does not damage the Competition Organiser's equipment. The Competitor's equipment shall comply with safety regulations.
- Should any Competitor supplied equipment fail or become unserviceable during the competition, no additional time allowance shall be made.
- Other personal hand tools

All working clothes and all tools shall comply with Host Country safety regulations.

Alignment aids for setting up test samples may be used, provided they are removed prior to welding.



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

Not applicable

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

Any material that may be used to assemble a project or part of a project is not allowed to be brought to the Competition.

No additional consumables or practice materials are allowed to be brought to the Competition.

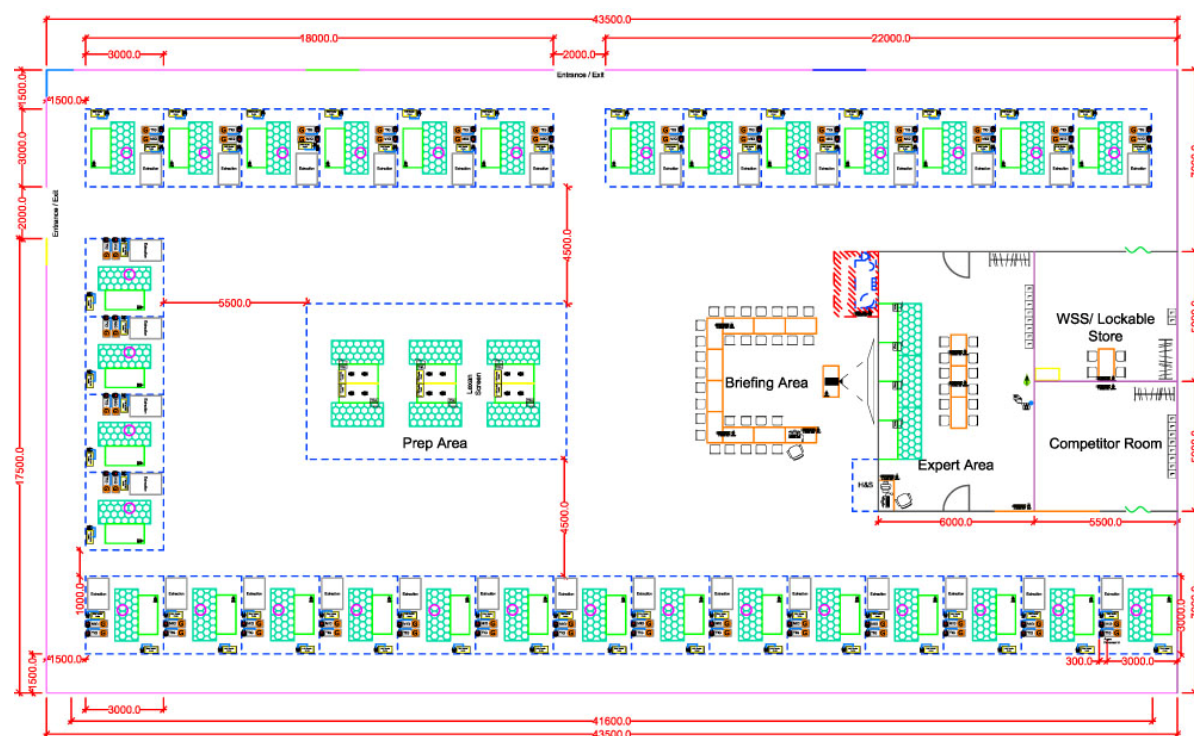
Only items in section 7.2.1 are allowed.

### 7.5 Sample workshop layouts

Workshop layouts from Calgary are available at:

[http://www.worldskills.org/index.php?option=com\\_halls&Itemid=540](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 for this skill.

- Try a trade
- Display screens
- Test Project descriptions and displays.
- Enhanced understanding of Competitor activity
- Competitor profiles
- Career opportunities
- Daily reporting of competition status

### 8.2 Sustainability

- Recycling
- Use of 'green' materials
- Use of completed Test Projects after Competition

## 9. APPENDIX

### 9.1 Selection of test plate and pipe projects

The horizontal row which has a country/region code in the right hand column is eligible for selection for the 2013 Competition.

<b>Selection of the test plate and pipe projects for WorldSkills Skill 10 Welding</b>			<b>SELECTED FOR 2013</b>
<b>Test Pipe 1A</b>			
<b>Positions</b>	<b>Root Pass</b>	<b>Fill and Cap</b>	
2 PC	GTAW 141	GTAW 141	
		SMAW 111	
	GMAW 135	GMAW 135	<b>NL</b>
	SMAW 111	SMAW 111	
5 UPHILL PF	GTAW 141	GTAW 141	
		SMAW 111	
	GMAW 135	GMAW 135	
	SMAW 111	SMAW 111	
6 UPHILL H-LO45	GTAW 141	GTAW 141	
		SMAW 111	<b>CA</b>
	GMAW 135	GMAW 135	<b>ID</b>
	SMAW 111	SMAW 111	<b>KR</b>
	GMAW 135	GMAW 135	

Test Plate 1B 10mm			
Positions	Root Pass	Fill and Cap	
1 PA	GTAW 141	SMAW 111	
		GMAW 135	
	SMAW 111	SMAW 111	AT
		FCAW 136	IR
	GMAW 135	GMAW 135	
FCAW 136			
2 PC	GTAW 141	SMAW 111	
		GMAW 135	
	SMAW 111	SMAW 111	DE
		FCAW 136	
	GMAW 135	GMAW 135	AE
FCAW 136			
3 UPHILL PF	GTAW 141	SMAW 111	
		GMAW 135	
	SMAW 111	SMAW 111	
		FCAW 136	
	GMAW 135	GMAW 135	
FCAW 136			
4 PE	GTAW 141	SMAW 111	
		GMAW 135	
	SMAW 111	SMAW 111	US
	GMAW 135	GMAW 135	
Test Plate 1C 16mm			
Positions	Root Pass	Fill and Cap	
1 PA		GMAW 135	
		FCAW 136	
	GMAW 135	GMAW 135	
		FCAW 136	
	SMAW 111	GMAW 135	
FCAW 136			
2 PC		GMAW 135	
		FCAW 136	
	GMAW 135	GMAW 135	CH
		FCAW 136	
	SMAW 111	GMAW 135	TH
FCAW 136			
3 UPHILL PF		GMAW 135	
		FCAW 136	
	GMAW 135	GMAW 135	
		FCAW 136	
	SMAW 111	GMAW 135	
FCAW 136		TW	
4 PE		GMAW 135	
	GMAW 135	GMAW 135	
	SMAW 111	GMAW 135	

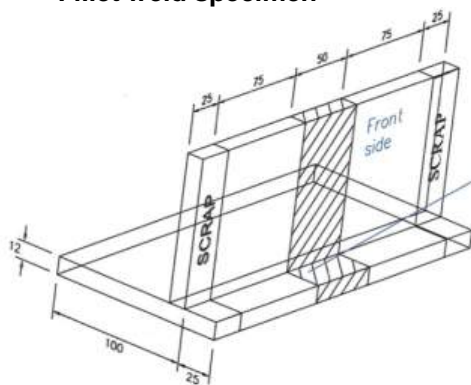
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<b>Fillet weld test 12mm – 2 coupons to be selected</b>		
<b>Positions</b>	<b>Process</b>	
1F PA	GMAW 135	<b>NZ</b>
	FCAW 136	
	SMAW 111	<b>ZA</b>
2F PB	GMAW 135	
	FCAW 136	<b>BR</b>
	SMAW 111	
3F PF	GMAW 135	<b>PT</b>
	FCAW 136	<b>MY</b>
	SMAW 111	<b>BE</b>
4F PD	GMAW 135	<b>FR</b>
	FCAW 136	
	SMAW 111	<b>UK</b>

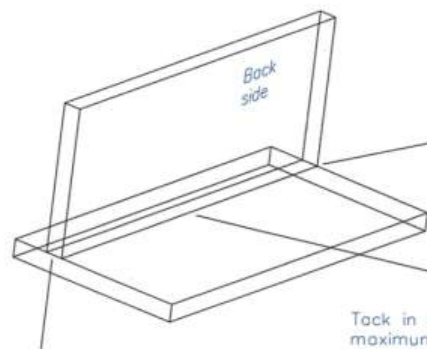
9.2 Coupon drawings

1	2	3	4	5	6	7	8	9	10																																				
A	B	C	D	E						F																																			
<p><b>TEST PIPE 1A</b> MATERIAL: CARBON STEEL PIPE 2 PCS <math>\varnothing</math> 114.3 O.D. x 8.56 WALL x 115 LONG</p> <p>EVALUATION: X-RAY ENTIRE WELD JOINT</p> <p>WELDING POSITION: ROOT PASS: FILL and GAP:</p>			<p><b>TEST PLATE 1B</b> MATERIAL: CARBON STEEL THICKNESS: 10mm</p> <p>WELDING POSITION: ROOT PASS: FILL and GAP:</p>			<p><b>TEST PLATE 1C</b> MATERIAL: CARBON STEEL THICKNESS: 15mm</p> <p>WELDING POSITION: ROOT PASS: FILL and GAP:</p>			<p><b>TEST PLATE 1D</b> MATERIAL: CARBON STEEL THICKNESS: 15mm</p> <p>WELDING POSITION: ROOT PASS: FILL and GAP:</p>			<p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>1. ANY PROCESS AND ANY POSITION MAY BE USED FOR TACKWELDING.</li> <li>2. MAXIMUM LENGTH OF TACKS: 15mm</li> <li>3. ALL PLATES OR PIPES ARE TO BE CHECKED BEFORE ANY WELDING COMMENCES.</li> <li>4. TEST PLATES OR PIPES MUST BE WELDED IN THE POSITION AS INDICATED FOR EACH TEST.</li> <li>5. NO GRINDING OR FINISHING OF ANY KIND AFTER WELDING IS COMPLETED.</li> <li>6. XXXX = CONTESTANT'S I.D.</li> </ol> <p><b>TEST PLATE 1E</b> MATERIAL: CARBON STEEL THICKNESS: 12mm</p> <p>WELDING POSITION: PROCESS:</p> <p><b>NOTE:</b> DEPOSIT A FILLET WELD ON THE FRONT SIDE OF THE JOINT WITH A 10mm <math>-0/+2</math> LEG LENGTH. BE DEPOSITED WITH WELDING ON ONE SIDE AND A MAXIMUM OF 3 RUNS. EDGE PREPARATION MUST REMAIN AT 90° TO THE PLATE FACE. NO GAP ALLOWED.</p> <p>EVALUATION: 1. VISUAL 2. BREAK TEST</p> <p><b>TEST PLATE 1F</b> MATERIAL: CARBON STEEL (CS) and ALL DIMENSIONS IN MILLIMETRES</p> <table border="1"> <tr> <th>Item Qty.</th> <th>Material</th> <th>Description</th> <th>Notes</th> </tr> <tr> <td>E 2</td> <td>CS</td> <td>Plate 12 x 100 x 250</td> <td></td> </tr> <tr> <td>D 2</td> <td>CS</td> <td>Plate 12 x 125 x 250</td> <td></td> </tr> <tr> <td>C 2</td> <td>CS</td> <td>Plate 16 x 150 x 350</td> <td>MILLED BEVEL</td> </tr> <tr> <td>B 2</td> <td>CS</td> <td>Plate 10 x 100 x 200</td> <td>MILLED BEVEL</td> </tr> <tr> <td>A 2</td> <td>CS</td> <td>Pipe <math>\varnothing</math> 114.3 O.D. x 8.56 wall x 115</td> <td>MILLED BEVEL</td> </tr> </table> <p>ALL MATERIAL CARBON STEEL (CS) and ALL DIMENSIONS IN MILLIMETRES</p> <p>Plate 12 x 100 x 250 Plate 12 x 125 x 250 Plate 16 x 150 x 350 Plate 10 x 100 x 200 Pipe <math>\varnothing</math> 114.3 O.D. x 8.56 wall x 115</p> <p>DETAIL OF MILLED BEVEL</p> <p>ROOT FACE YOUR CHOICE</p> <p>(A,B,C) <math>+16</math> (R) <math>-16</math> (R) <math>-0.50</math> (R)</p>					Item Qty.	Material	Description	Notes	E 2	CS	Plate 12 x 100 x 250		D 2	CS	Plate 12 x 125 x 250		C 2	CS	Plate 16 x 150 x 350	MILLED BEVEL	B 2	CS	Plate 10 x 100 x 200	MILLED BEVEL	A 2	CS	Pipe $\varnothing$ 114.3 O.D. x 8.56 wall x 115	MILLED BEVEL	<p>DO NOT SCALE DRAWING</p>				
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<p>WORLD SKILLS INTERNATIONAL</p> <p>BISE # 10 WELDING Scale: 1:1 Date: 14/03/09 Drawn / Design by: John Kohlmeier Description: TEST PLATES/PPE Page: A3 Rev: 1 Drawing No: TP10_4109_DAV1_Generac Page 1 of 1</p>																																													

### 9.3 Fillet weld specimen



Stop/start in the middle  
50mm section on the root  
run...



Tack weld on this end

Tack in centre to a  
maximum length of  
25mm

Tack weld on this end

#### Instructions:

Deposit a fillet weld on the front side of the plate with a 10mm +1/-1 leg length. Weld to be deposited with a minimum of 2 runs and a maximum of 3 runs. Edge preparation must remain at 90° to the plate face. No gap allowed.

#### Material

1 off 250mm x 125mm x 12mm CS plate  
1 off 250mm x 100mm x 12mm CS plate