



## National Skill Competitions

### Skill- Welding

Category: Manufacturing & Engineering  
Technology



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## Section - A

### A. Preface

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#### **Skill Explained:**

Welding is a critical process that is controlled by both National and International standards and specifications to control the quality of the deposited weld metal and the skill of the welder.

A welder prepares and joins a range of metals and metallic alloys using mainly processes where an electric arc is the heat source. Electric arc processes utilize a gas shield or a flux to protect the molten weld area from contamination by the surrounding atmosphere. A welder needs to be able to interpret engineering drawings, standards and symbols and correctly translate these requirements into accurate structures and fabrications.

Welders need to have a thorough knowledge and understanding of safe working practices, personal protection equipment and the hazards and practices associated with welding and fabrication industries. They need to gain specific knowledge of a wide range of welding equipment and processes as well as an understanding of how welding will affect the structure of the material being welded well. They need to be familiar with electricity and how it is utilized for welding.

Welders join sections, pipe and plate and fabricate large and small pressure vessels. A welder prepares, assembles and joins a wide range of metals and metal alloys using various welding processes including manual metal arc welding/shielded metal arc welding metal arc gas shielded welding/gas metal arc welding, Tungsten arc gas shielded welding/gas tungsten arc welding and flux cored arc welding. A welder will use mainly processes where the heat utilized for welding will be an electric arc to join a range of materials including the commonly joined and fabricated materials – carbon steel, stainless steels, aluminium and copper and their associated alloys. They must be able to select the correct equipment, process variables and welding technique depending upon the material being joined.

Welders may use thermal cutting processes and should be able to identify the correct preparation for joining as applied to the type, thickness and intended use of the joint. They use grinding and cutting equipment to prepare welded joints. Modern methods of joining, as well as those noted above, include mechanized processes such as submerged arc, plasma arc, stud welding and laser welding.

A welder can work in a unit or factory which produces fabrications and/or structures for industries as diverse as civil engineering, mechanical engineering, transport, marine engineering, construction, service, and leisure industries. Welders also work on site preparation, construction, and the repair and maintenance of structures. A welder can work in many locations and situations, ranging from a bench in a factory, to shipyards, power stations and off-shore structures. Welders also work in engineering, construction, power generating, and petro-chemical plants. The working environment may include hazardous environments such as off shore, extreme weather conditions and also confined spaces where access to the joint to be welded is restricted.

The modern welder may specialize in one or a number of welding processes and environments. He or she may also be asked to work in exotic alloys such as duplex and super duplex stainless steels and cupronickels. Welders are required to carry out the finest



work where faults and failure may have the most serious consequences in terms of cost, safety and environmental damage.

### **Eligibility Criteria (for IndiaSkills 2018 and World Skills 2019):**

Competitors born on or after 01 Jan 1997 are only eligible to attend the Competition.

### **Total Duration: As per Modules**

### **Associated documents**

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

- WSI – Competition Rules
- WSI – WorldSkills Standards Specification framework
- WSI – WorldSkills Assessment Strategy
- WSI Online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations
- ISO 5817-Welding—Fusion-welded joints in steel, nickel, titanium and their alloys.
- ISO 9606-Qualification testing of welders Part 1: steels.
- ISO 10042-Welding—Arc-welded joints in Aluminium and it's alloys.
- ISO 9017-Destructive tests on welds in metallic materials- fracture tests.
- ISO 15608-Welding – Guidelines for metallic materials grouping system.
- ISO 17635- Non-destructive testing of welds – General rules for metallic materials.
- ISO 10025- Hot rolled products of structural steels. General Technical delivery conditions.
- ISO 2553-Welding and allied processes – Symbolic representation on drawings – Welded joints.
- AWS A2.4-Standard Symbols for welding Brazing, and Non-Destructive Examination.
- AWS A3.0-Standard Welding Terms and Definitions.

Note: Where a conflict arises, the ISO standards shall have precedence. If no ISO standard is applicable, then the relevant AWS standard shall be used

## B. Test Project

### General Requirements

Overall, the Test Project shall be modular and are standalone assessments of the Competitors skill

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, 350 Amps with Pulse or Synergic 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 or 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 Organizer may be used. Practice plates for the Competition.

The Competition Organizer shall provide two sets (four pieces each) of material for each of the test. Coupons and ten 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 (2005), Group one, two or three for low carbon steel;

Group eight for stainless steel (300 series), and aluminium in the 5000 and 6000 series.

Chosen material shall be listed on the infrastructure list with full detail of the material grouping and classification. MTR's shall be provided to the experts to review for accuracy and to approve before cutting of the material commences.

Plates

- High quality low carbon steel, 2 mm to 12 mm thick to ISO 10025;
- For pressure vessel, plates are to have through-thickness tested certification;
- Austenitic stainless steel, 1.5 mm to 6 mm thick e.g. 18/8 types X5CrNi 18;
- Aluminium, 1.5 mm to 6 mm thick e.g. 5000 or 6000 series.

Pipes

- High quality low carbon steel pipes to ISO 10025, dia. 40mm to 150mm, wall thickness 1.6mm to 10mm;
- Stainless steel and aluminium, diameter 25mm to 50mm, wall thickness 1.6mm to 6mm.

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



## Test Project Modules



Weld Coupons.pdf



Pressure Vessel.pdf



S.S(Material)-Model.pdf



S.S(E)-Model.pdf



S.S(A)-Model.pdf



Aluminum(E)-Model.pdf



Aluminum(A)-Model.pdf



AL(Material)-Model.pdf

## Section – C

### C. Marking Scheme

#### Marking Scheme:

The Assessment is done by awarding points by adopting two methods - Measurement and Judgments.

- Measurement - One which is measurable  
Aspects are criteria's which are Measured for assessment. Maximum weightage is given to measurable outcomes.
- Judgments - Based on Industry expectations

Aspects are criteria's which are judged for assessment

#### ASSESSMENT AND MARKING USING JUDGEMENT

Judgment uses a scale of 0-3. 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

#### Example-Judgment Marking

If maximum marks for Judgment criteria is 1 and if all 3 Experts (Juries) give 3 points to a candidate, the candidate will get 1 mark for that aspect. If 2 Experts give 3 and 1 Expert gives 2 points, then candidate will get  $(3+3+2)/9*1 = 0.89$  marks for that aspect out of 1 mark.

#### Completion of 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.

The level of imperfection assessment to be no less than that expected for the qualification of a welder to ISO 9606 Qualification of welders – fusion welding part 1: Steels and part 2: Aluminium and Aluminium alloys. The level of imperfection no less than level 'B' of ISO 5817 Welding – Fusion welded joints in steel, nickel titanium and their alloys (beam welding excluded) – Quality levels. For RT inspections of the test plates and pipe, digital RT shall be used where possible, but if not possible, double loaded film practices shall be used. Both practices to be performed IAW ISO 17635.

ISO 10042 Arc – welded joints in Aluminium and its weldable alloys – Guidance on Quality levels for imperfections

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?	Task two (PV) $\leq 1.5$ mm

IMPERFECTION DESCRIPTION	EXPLANATION	LIMITS FOR IMPERFECTIONS
	(From crown to crater bottom, or crown of stop and crown of restart)	
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 two (PV) Incremental marking max. two defects
7. Surface or internal Porosity and Gas Pores	Is the weld metal free of porosity?	Task one (Coupon X-Ray) - See International Standard ISO 5817 Task one (Coupon destructive testing) - Incremental marking. Two defects Task two (PV) Incremental marking max. two defects Task three (AL) - Incremental marking max. two defects Task four (SS) - Incremental marking max. two defects
8. Undercut	Is the weld joint free from undercut?	≤ 0.5mm
9. Overlap (Over roll)	Is the weld joint completely free of overlap (over roll)?	Not permitted



IMPERFECTION DESCRIPTION	EXPLANATION	LIMITS FOR IMPERFECTIONS
10. Lack of Penetration	Is the joint free from lack of penetration or root fusion?	Task one (Coupon X-Ray) See International Standard ISO 5817 Task one (Coupon Visual) – Not permitted. Task three (AL) – Incremental marking Task four (SS) - Incremental marking
11. Excessive root concavity (shrinkage groove)	Is the weld penetration free of excessive root concavity “suck back”?	Task one - See International Standard ISO 5817
12. Excessive Penetration	Is the joint free of excessive penetration?	Task one (Coupon) - ≤ 2.0 mm Task two (PV)– N/A Task three (AL) - ≤ 3.0 mm Task four (SS) - ≤ 2.5 mm
13. Excessive Face Reinforcement (height)	Is the weld joint free of excessive face reinforcement?	Task one (Fillet)- ≤ 3.0 mm Task one (Butt) - ≤ 2.5 mm Task two (PV) - ≤ 2.5 mm Task three (AL) - ≤ 1.5 mm Task four (SS) - ≤ 1.5 mm
14. Incompletely filled groove	Is the butt weld groove completely filled?	Not Permitted
15. Linear Misalignment (high/low)	Is the joint free from linear (high/low) misalignment?	Task one - See International Standard ISO 5817 Task two (PV) - ≤ 1.0 mm Task three (AL) - ≤ 1.0 mm Task four (SS) - ≤ 1.0 mm
16. Fillet Weld Sizes	Are fillet sizes in accordance with specifications? (Measurement leg length)	Task one (Coupon) -0/+2 mm Task two (PV) -0/+2 mm Task three (AL) -0/+2 mm Task four (SS) -0/+1 mm

17. Full Radius Contour	Does the joint exhibit a full radius contour = to plate thickness?	Full radius contour
18. Excessive Width of Butt Weld Face	Are bead widths uniform and regular? (Measure narrowest portion vs. widest portion)	Task one (Coupon) - $\leq 2.0$ mm Task two (PV) - $\leq 2.0$ mm Task three (AL) - $\leq 1.5$ mm Task four (SS) - $\leq 1.0$ mm

## 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. Welds with no recordable imperfections will be an 'A' category pass;

Procedure for performing fracture tests on the Fillet welded coupon;

1. Each test piece shall be positioned for breaking in accordance with ISO 9017 Destructive tests on welds in metallic materials – Fracture tests;
2. Each coupon shall be visually assessed after breaking for lack of fusion, inclusions, 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 pressurize to city pressure;
4. Ensure vessel is fully dry on outside;
5. If vessel exhibits a leak – Score one point and test is complete;
6. If no leaks are observed at city pressure, the vessel will be further pressurized in stages (minimum of FOUR stages) to the maximum pressure normally 69bar (1000 psi) dependant on pressure pump available;
7. Each hold point will be held for 60 seconds. If no leak is detected the pressure will be increased in stages until the vessel is pressurized to the maximum pressure;
8. If the vessel leaks at any stage in the hydrostatic test the marks will be awarded appropriate to the last successful hold point;
9. Drain all water from the vessel.

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

### Mark Distribution

SECTION	RELATIVE IMPORTANCE (%)
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1	Work Organization and Management	10
2	Preparation and Assembly Techniques	10
3	Welding Materials	10
4	SMAW (111) and GMAW (135) Process	25
5	FCAW-G (136) Process	10
6	GTAW (141) Process	15
7	Finishing, Quality Assurance, and Testing	20
	<b>Total</b>	<b>100</b>



## Section – D

### D. Health, Safety, and Environment

1. All accredited participants, and supporting volunteers will abide by rules and regulations with regards to Health, Safety, and Environment of the Competition venue.
2. All participants, technicians and supporting staff will wear the required protective Personnel clothing. Protective clothing must be selected according to the activity and related risk. When working with rotating machines, individuals must ensure that close-fitting clothing is worn, in order to avoid clothing becoming entangled in the equipment. Jewellery and long hair are a safety hazard and shall be taken off or covered.
3. All participants will assume liability for all risks of injury and damage to property, loss of property, which might be associated with or result from participation in the event. The organizers will not be liable for any damage, however in case of Injury the competitor will immediately inform the immediate organizer for medical attention.
4. Competitors should use during the Competition the following personal protective equipment. All safety equipment must comply with Host Country Health and Safety requirements.
  - Safety Glasses;
  - Body protection – flame retardant material;
  - Foot protection – from dropping objects;
  - Hand Protection – heat and arc radiation;
  - Face protection – Head or Hand welding shield;
  - Hearing Protection;
  - Clear face shield (grinding, may be integrated in the welding head shield);
  - Fume and particle protection
  - Safety Shoes etc,...