

MANUFACTURING AND ENGINEERING TECHNOLOGY

# Construction Metal Work



## WorldSkills Occupational Standards

# WorldSkills Occupational Standards (WSOS)

## Occupation description and WSOS

### The name of the occupation is

Construction Metal Work

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

Construction metalworking is the assembly and installation of steel structures, vessels and components that encompass the food & dairy, pharmaceutical & chemical industries, architectural engineering and structural steel work for buildings and bridges. Very high standards of finish and quality are expected from the construction metalworker as food and pharmaceutical products are transported and produced from steel components that a construction metalworker would assemble. High-rise buildings, stadiums and bridges are erected using the skills of the construction metalworker along with cutting edge architectural designs that affect the modern landscape for innovative building designs.

The skills required for construction metalworking involve:

- A thorough knowledge and understanding of safe working practices, personal protection equipment and the hazards and practices associated with the construction metalworking industry
- The interpretation of engineering drawings
- Knowledge of mathematical calculations, geometrical construction techniques and computer-aided design and drafting software applications
- Knowledge and use of new technologies for developing patterns and other purposes
- A comprehensive knowledge of a range of industrial cutting and forming processes to suit a range of steels and alloys including low carbon steel, stainless steel, alloy steels, aluminium alloys and also working with different tube & pipe standards
- Shaping and forming these steel components with the aid of thermal processes and a range of machinery used in cutting, bending, and rolling metal plate
- Using modern thermal cutting processes such as plasma, laser and waterjet cutting techniques through the use of computer-aided design (CAD) software that architects, engineers, and construction professionals rely on to create precise 2D drawings
- Applying a range of welding processes such as Manual Metal Arc welding, TIG/TAG (Tungsten Inert Gas and Tungsten Active Gas) welding, MIG/MAG (Metal Inert Gas and Metal Active Gas) welding to assemble and join materials into structures and products

Work organization and self-management, working precisely and accurately, concentration, attention to detail, communication and interpersonal skills, problem solving, innovation and creativity, are the universal attributes of the construction metal worker.

Construction metalworkers are highly skilled individuals who are able to work autonomously, contribute to a technical team, take personal responsibility for completing projects to approved quality standards in a timely manner, and interact effectively with colleagues and customers in an industrial setting. Every step in the process matters and mistakes are largely irreversible and very costly.

With the international mobility of people, construction metalworkers face rapidly expanding opportunities and challenges. For talented construction metalworkers, there are many commercial and international opportunities, which carry with them the need to understand and work with diverse cultures and trends.

## General notes on the WSOS

The WSOS specifies the knowledge, understanding, and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business ([www.worldskills.org/WSOS](http://www.worldskills.org/WSOS)).

The skill competition is intended to reflect international best practice as described by the WSOS, and to the extent that it is able to. 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 that are set out in the Standards Specification. 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, provided that this does not distort the weightings assigned by the Standards.

# WorldSkills Occupational Standards

Section	Relative importance (%)
<b>1 Work organization and management</b>	<b>5</b>

The individual needs to know and understand:

- Health and safety legislation, obligations, and regulations which control the work process within the construction metal work industry
- The range of Personal Protective Equipment (PPE) used in the construction metalwork industry in accordance with EN 16111, EN 166, EN 420 and EN ISO 20345 or their equivalents
- The safe use, precautions, maintenance, and adjustment for:
- The mechanical cutting, grinding, and shearing, using powered guillotines of low carbon steel, stainless steel, and aluminium
- Thermal cutting equipment and its associated gases
- Mechanical and hand bending, their associated tools and equipment
- Welding processes using AC and DC power supply and the associated hazards on welding machines
- The requirements and possibilities for environmental management and sustainability within the industry
- The use of local exhaust ventilation (LEV) and the use of powered air respirator welding helmets with particle filters to minimize the risks associated with welding fumes
- Principles of work planning, operations, and time management
- The significance of planning, accuracy, checking, and attention to detail in all working practices
- The role of the individual in maintaining a successful business
- The value of managing their own continuing professional development

The individual shall be able to:

- Follow health and safety standards, rules, and regulations
- Maintain safe and clean working environments
- Identify and use the appropriate PPE, including eye, ear and safety footwear along with dust, fume and noise control
- Select, use, clean, maintain, and store all hand and powered tools and equipment safely
- Select, use, and store all materials safely and correctly avoiding cross contamination between different material types
- Plan work areas to maximize efficiency and maintain the discipline of regular tidying and cleaning
- Carry out work with consideration to the environmental and sustainability issues relating to the industry
- Complete projects and assignments safely, accurately, and efficiently, as specified and within projected timelines
- Critically evaluate own work

Section	Relative importance (%)
<b>2 Communication and interpersonal skills</b>	<b>5</b>

The individual needs to know and understand:

- The roles and requirements of managers, customers, architects, design engineers, and related tradespersons
- Detailed instructions from customers, architects, design engineers, and Engineering Supervisors
- Non-verbal communication such as drawings, guidelines, international standards, etc.
- The importance of good teamwork and effective methods of communication
- The value of building and maintaining productive working relationships with colleagues and managers
- The importance of swiftly resolving misunderstandings and conflicting demands
- Progress reporting methods

The individual shall be able to:

- Gain the trust of managers and clients and manage expectations positively
- Visualize and interpret clients' wishes, giving advice and making recommendations or providing options that meet/improve their design and budgetary requirements
- Liaise with suppliers to negotiate prices and place orders
- Produce estimates for clients
- Recognize, respect, and adapt to changing circumstances and requirements
- Communicate with others with reference to drawings, variations to documents and restrictions
- Follow instructions, meet deadlines, and report on progress in the appropriate format
- Clearly communicate with colleagues where drawings, variations to the documents, and work restrictions are required
- Read and use all necessary manuals, drawings, bills of materials, guidelines, etc. to achieve good results
- Integrate, facilitate communication, and work positively within team situations
- Follow instructions, meet deadlines and report on progress in appropriate formats



Section	Relative importance (%)
<b>3 Marking out techniques</b>	<b>15</b>

The individual needs to know and understand:

- 1<sup>st</sup> and 3<sup>rd</sup> angle orthographic projections represented on drawings
- Geometrical tolerancing in accordance with ISO 7083 and their relationship to accuracy
- Weld symbols used on engineering drawings in accordance with ISO 2553 – System A
- How to interpret bills of materials (BOM)
- ISO standard numbers and their relevance
- Mathematical calculations
- Geometrical development methods for intersecting parts and flat pattern development
- How to use computer-aided design software (AutoCAD) to create precise 2D drawings, parts, and developments
- The selection, use, and maintenance of measuring and checking equipment
- Structural steel joint connection types

The individual shall be able to:

- Interpret engineering drawing conventions and symbols in accordance with ISO 129, ISO 128, ISO 7083
- Perform standard mathematical calculations including areas, volumes, Pythagoras' theorem, trigonometry, and unit conversion
- Prepare comprehensive cutting lists from BOMs
- Use a range of plate fabrication development techniques to include, radial line, parallel line, and triangulation methods
- Mark out, form, and assemble structural steel joint connections

<b>4 Cutting techniques</b>	<b>15</b>
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The individual needs to know and understand:

- The selection, use and maintenance of mechanical equipment used such as shears, corner shears, guillotine, saws, universal iron workers and grinders
- The importance of rake angle, blade clearance, material type & thickness when using a powered guillotine
- Processes for cutting/grinding materials to given tolerances
- The selection and use of thermal cutting equipment to include manual oxy-acetylene torches (with guides and circle cutters) along with automated plasma, laser and waterjet cutting techniques
- The techniques for punching, countersinking, drilling, tapping, and reaming holes in steels, alloys, and aluminium

Section	Relative importance (%)
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The individual shall be able to:

- Cut and assemble using drawing and cutting instructions to given tolerances
- Set up and use powered guillotines to accurately cut steels, alloys, and aluminium
- Set up and use various size angle grinders to cut/grind materials using the correct size & type of cutting/grinding discs to given tolerances
- Use thermal cutting equipment to cut steels, alloys and aluminium using manual and automated cutting methods
- Set up and use hand and power tools to cut, punch, drill, countersink, tap and ream holes in a variety of metals

<b>5</b>	<b>Forming techniques</b>	<b>20</b>
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The individual needs to know and understand:

- The adjustment and operation of manual or mechanical forming machines
- The selection, adjustment, and operation of:
  - Vertical and horizontal brake presses
  - Pinch and pyramid rolls
  - Profile (section) bending rolls
- Oxy-fuel gas heating equipment
- Flat bar and pipe benders
- Perform mathematical calculations using the neutral line (mean diameter) and bending allowance ratios to cold and hot form steels, alloys, and aluminium

The individual shall be able to:

- Use pinch and pyramid rolls to produce cylindrical shapes
- Use profile bending rolls, flat bar and pipe benders to cold form steels, alloys and aluminium and form various steel sections
- Adjust and use oxy-fuel gas equipment to hot form low carbon steel, bend solid round bar, and form various steel sections
- Bend and form straight bends to any angle using a vertical or horizontal brake press from steels, alloys, and aluminium, using the appropriate mathematical calculations

Section	Relative importance (%)
<b>6 Assembly and finishing techniques</b>	<b>30</b>

The individual needs to know and understand:

- Assembly techniques and associated symbols used in engineering drawings and project descriptions
- The use of hand and power tools for assembly
- The types, selection and operation of pivot and locking devices in common use
- The range of mechanical fastenings used in the construction metalwork industry including:
  - Nuts and bolts
  - Locking and flat washers
  - Screws
  - Manufacturers' mechanical fasteners
- The range of edge, surface and joint finishes available
- The range of tools used to achieve required finishes
- The use of standard techniques for checking dimensional stability

The individual shall be able to:

- Use correct assembly skills as required
- Select and use hand and power tools for assembly
- Construct moving pivots and locking devices as required
- Select, place, and fix mechanical fittings as required for assembly
- Finish project edges, surfaces and joints as required, using hand and power tools to include:
  - Files
  - Wire brushes
  - Abrasives
  - Deburring tools
- Use non-chemical cleaning techniques for all welds
- Check assembled parts/structures for geometric dimensioning & tolerancing accuracy

<b>7 Welding and joining techniques</b>	<b>10</b>
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The individual needs to know and understand:

- The selection and use of welding processes including:
  - Manual metal arc welding (111)
  - Gas metal arc welding (135)
  - Gas tungsten arc welding (141)
- The correct machine settings to be aligned to:
  - Welding polarity
  - Welding position
  - Material
  - Material thickness



Section	Relative importance (%)
<ul style="list-style-type: none"> <li>• Filler material and feed speed</li> <li>• The range of welding consumables available, their selection and storage</li> <li>• Preparation techniques prior to welding, how surface contamination can influence the finished weld characteristics</li> <li>• Methods of distortion control in steels, alloys, and aluminium</li> <li>• Weld Symbols in accordance with ISO 2553 – System A &amp; B</li> <li>• Weld defects, their causes, and the methods by which weld defects can be avoided</li> <li>• Welding safety and hazards associated with welding processes</li> </ul>	
<hr/> The individual shall be able to:	
<ul style="list-style-type: none"> <li>• Use manual metal arc welding equipment to weld joints in low carbon steel and stainless steel</li> <li>• Use gas metal arc welding equipment to weld joints in low carbon steel and stainless steels</li> <li>• Use gas tungsten arc welding equipment to weld joints in low carbon steel, stainless steels, and aluminium with no need for weld penetration</li> <li>• Set up welding equipment to manufacturer's specification including (but not limited to): <ul style="list-style-type: none"> <li>• Welding polarity</li> <li>• Welding position</li> <li>• Welding amperage</li> <li>• Welding voltage</li> <li>• Wire feed speed</li> <li>• Travel speed</li> <li>• Travel/electrode angles</li> <li>• Mode of metal transfer</li> <li>• Material type</li> </ul> </li> <li>• Remove surface contamination and prepare joints for welding regarding, type, and material thickness</li> <li>• Interpret the number of welds and their location from the relevant weld symbols</li> <li>• Set up and operate appropriate controls and welding technique to minimize and correct distortion</li> <li>• Weld in the following positions in accordance to ISO 6947 <ul style="list-style-type: none"> <li>• PA</li> <li>• PB</li> </ul> </li> <li>• Identify and repair weld defects</li> </ul>	
<b>Total</b>	<b>100</b>

## References for industry consultation

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/](http://www.onetonline.org/))

This WSOS appears most closely to relate to *Structural Metal Fabricators and Fitters*:  
<https://www.onetonline.org/link/summary/51-2041.00>

The links also enable adjacent occupations to be reviewed.

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 2022.

Organization	Contact name
TEG Engineering (Global)	Paul Gill, Welding/Fabrication Supervisor
CDS Architectural Metalwork (United Kingdom and Ireland)	Martin Stapleton, Director