Welders

NOC 7265

Introduction

Welders operate welding equipment to weld ferrous and non-ferrous metals. This unit group also includes machine operators who operate previously set up production welding, brazing and soldering equipment. They are employed by companies that manufacture structural steel and platework, boilers, heavy machinery, aircraft and ships and other metal products, and by welding contractors and welding shops, or they may be self-employed.

The most important Essential Skills for Welders are:

- Document Use
- Numeracy

Document Sections

- Reading Text
- Document Use
- Writing
- Numeracy
- Oral Communication
- Thinking Skills
    - Problem Solving
    - Decision Making
    - Critical Thinking
    - Job Task Planning and Organizing
    - Significant Use of Memory
    - Finding Information
- Working with Others
- Computer Use
- Continuous Learning
- Notes

A. Reading Text

Reading Text

Tasks	Complexity Level	Examples
Typical	2 to 3	Welders: • read the relevant section of company policies to understand the procedure for requesting time off. (2) • read WHMIS materials to find out how to handle hazardous materials such as gas. (2) • read equipment and safety manuals that describe safe operating procedures, e.g., how to operate hand-held grinders. (2) • read posted memos about safety concerns in the workplace. (2)
Most Complex	3	• read safe work permits to learn the safety guidelines and operational procedures for a job. The permit also provides a general description of the job and specifies what must be done before the worker can start welding in order to make the work site safe. (2) • read codes and specifications, for example, Canadian Standards Association (CSA) W59 and, American Society of Mechanical Engineers (ASME) Section IX, to prepare for welding projects. (3) • read detailed welding procedures specifications developed by governing bodies, namely the ASME, and the Canadian Welding Bureau (CWB). Welders must follow the procedures exactly as specified, for instance, use the correct rod type, weld to the specified thickness, use the recommended gas. (3)

Reading Summary

The symbol √ is explained in the Use of Symbols section.

	Purpose for Reading			
Type of Text	**To scan for specific information/To locate information**	**To skim for overall meaning, to get the 'gist'**	**To read the full text to understand or to learn**	**To read the full text to critique or to evaluate**
Forms				
Labels	√			
Notes, Letters, Memos	√	√	√	
Manuals, Specifications, Regulations	√	√	√	
Reports, Books, Journals				

B. Document Use

Document Use

Tasks	**Complexity Level**	**Examples**
Typical	1 to 4	Welders: • use checklists to learn and follow proper work procedures and safety guidelines, e.g., follow instructions about how to properly rig a load so that it is secure and will not fall when in transport. (1) • observe signs in the workplace that communicate safety information such as signs showing where there are high noise levels. This information serves as a reminder to workers about the need for hearing protection. (1) • observe colours of pipes and lines in the workplace that indicate their contents, such as type of gas. (1) • observe the tag on each work project to identify its status, for example, welding complete, welding repair, priority. (1)

B. Document Use

Document Use

Most Complex	4 to 4	• track the progress of projects on route travellers or drawings by checking off listed tasks as they are completed. (1) • identify the capacity of rigging by referring to the markings (e.g., stamp, metal plate, tag) on the equipment. (1) • compare colour coding on metals to a colour code chart in order to identify its grade and alloy. (2) • fill in invoice forms or reports for employers showing tasks completed, materials used, the hours worked and how much to charge customers. (2) • read posted memos about safety concerns in the workplace. (2) • complete time sheets or a daily log, recording information such as the job number, the blueprint number, the weld identification numbers from the blueprint, welding procedures used and the time completed. (2) • may read maps to locate a new work site. An oil company will often provide a map showing company roads in remote locations. (2) • may observe digital photos of other projects on a computer screen to review the layout and welding procedure with the supervisor. They discuss with the supervisor how the layout and welding procedure of these projects could be altered to suit the needs of a current project. (3) • review notes on blueprints and/or welding procedures specifications (WPS) to review messages from the engineering department about materials and procedures. (3) • interpret and continually refer to diagrams and tables on blueprints, which may be up to 8 pages long, to determine material requirements and measurements; the type, size, location and starting position of welds; the welding process (e.g., flux core); and other engineering requirements. Much of this information is communicated via symbols and numbers. (4)

Examples

- create sketches and/or scale drawings for small projects specifying layouts and material type, size and location.

Document Use Summary

- Read signs, labels or lists.
- Complete forms by marking check boxes, recording numerical information or entering words, phrases, sentences or text of a paragraph or more. The list of specific tasks varies depending on what was reported.
- Read tables, schedules or other table-like text (e.g., read work shift schedules).
- Enter information on tables, schedules or other table-like text.
- Obtain specific information from graphs or charts.
- Recognize common angles such as 15, 30, 45 and 90 degrees.
- Draw, sketch or form common shapes such as circles, triangles, spheres, rectangles, squares, etc.
- Interpret scale drawings (e.g. blueprints or maps).
- Take measurements from scale drawings.
- Draw to scale.
- Read schematic drawings (e.g. electrical schematics).
- Make sketches.
- Obtain information from sketches, pictures or icons (e.g., computer toolbars).

C. Writing

Writing

Tasks	Complexity Level	Examples
Typical	1	Welders: • fill in invoice forms or reports for employers with tasks completed, materials used, the hours worked and how much to charge customers. (1) • record any changes made to the specified parameters on the work sheet, e.g., different wire speed. (1)
Most Complex	2 to 3	• complete time sheets or a daily log, noting information such as the job number, the blueprint number, weld identification numbers from the blueprint, welding procedure and time completed. (1) • complete accident and incident reports for the Workers' Compensation Board (WCB). (2) • may write safety guidelines for operating company equipment. (3)

Length	To organize/ to remember	To keep a record/to document	To inform/ to request information	To persuade/ to justify a request	To present an analysis or comparison	To present an evaluation or critique	To entertain
Text requiring less than one paragraph of new text	√	√	√				
Text rarely requiring more than one paragraph		√	√				
Longer text			√				

D. Numeracy

The symbol √ is explained in the Use of Symbols section.

Numeracy

Tasks	Complexity Level	Examples
√ Money Math	2	Welders: • may prepare invoices for clients noting the cost per unit (e.g., $50/hour) and then multiplying the cost of each unit by the number of units provided to calculate the charge for materials and labour. (Money Math), (2) • measure degrees of angles by using a level with a digital readout. (Measurement and Calculation Math), (1) • add various combinations of a structure's pieces prior to ordering materials for a project in order to avoid ordering excess amounts. For example, calculate how to get the maximum number of pieces out of a 60' length of pipe. (Measurement and Calculation Math), (2)
√ Measurement and Calculation Math	1 to 4	
√ Data Analysis Math	1	

√ Numerical Estimation	2 to3	• measure pieces for structures using International System of Units (SI) to the Imperial measurement system; and convert measurements from both systems. (Measurement and Calculation Math), (2) • calculate the dimensions of structural members (e.g., pipe, steel) in cases where allowance has to be made for fittings. The "take off" and "make up" dimensions have to be added to and subtracted from the overall dimension to arrive at the length of structural piece needed. (Measurement and Calculation Math), (2) • calculate the volume, diameter and circumference of tanks when fabricating pieces for them. (Measurement and Calculation Math), (3) • take measurements of elevations using a builder's level and tape measure during construction to ensure that components (e.g., piping) are level. (Measurement and Calculation Math), (3) • calculate "offsets". They use trigonometric constants to determine the length of the hypotenuse. For instance, to calculate the length of a pipe that goes on a 45 degree angle for a horizontal distance of 2 feet, multiply 2 feet by the constant 1.414 to determine the diagonal distance. (Measurement and Calculation Math), (4) • check bills or requisitions to ensure the amount of materials is accurate. (Data Analysis Math), (1) • estimate the quantity of consumables, such as welding rods or wire, required to complete a job based on the volume of welding to be done (Numerical Estimation), (2) • estimate the weight of a load for rigging by considering its size and density. (Numerical Estimation), (2) • may estimate the cost of work by considering the amount of materials and labour required and their price per unit. The complexity of the estimation is influenced by factors such as ease of access to the weld locations, the types of materials, and the welding process used. (Numerical Estimation), (3)

Math Skills Summary

a. Mathematical Foundations Used

The symbol √ is explained in the Use of Symbols section.

Mathematical Foundations Used

Code	Tasks	Examples
	Number Concepts	
√	Whole Numbers	Read and write, count, round off, add or subtract, multiply or divide whole numbers. For example, counting passes on cap welds to ensure the number of passes meets specifications, reading the number of pieces of a specific dimension and grade on a blueprint, observing readings on pressure and temperature gauges.
√	Integers	Read and write, add or subtract, multiply or divide integers. For example, reading distances on blueprints such as - 1 means to place the item one inch back from the reference point.
√	Rational Numbers - Fractions	Read and write, add or subtract fractions, multiply or divide by a fraction, multiply or divide fractions. For example, reading and working with Imperial measurements, e.g., welding rods are available in a variety of sizes such as 3/32, 1/8, ¼; reading the spacing requirements between welds on structures; determining the spacing between welds when fabricating a handrail.
√	Rational Numbers - Decimals	Read and write, round off, add or subtract decimals, multiply or divide by a decimal, multiply or divide decimals. For example, adding and subtracting metres, decimetres and centimetres.
√	Rational Numbers - Percent	Read and write percents, calculate the percent one number is of another, calculate a percent of a number. For example, estimating the percentage of the job that has been completed.
√	Equivalent Rational Numbers	Convert between fractions and decimals or percentages. Convert between decimals and percentages. For example, convert measurements taken in decimals (e.g., thousandths of an inch) to common fractions in order to select the appropriate size of tool, e.g., shims, drill bits.
√	Other Real Numbers	Use powers and roots, scientific notation, significant digits. For example, using square roots when fabricating stairs to calculate the length of the hypotenuse, using powers to express the volume of tanks.

Code	Tasks	Examples
		Patterns and Relations
√	Equations and Formulae	Solve problems by constructing and solving equations with one unknown. Use formulae by inserting quantities for variables and solving. For example, using Pythagorean Theorem to determine the length of one side of a triangle, calculating the correct angles for rigging loads.
√	Use of Rate, Ratio and Proportion	Use a rate showing comparison between two quantities with different units. Use a ratio showing comparison between two quantities with the same units. For example, using a rate when adjusting the flow setting on a regulator to the appropriate litres per minute, using a ratio when expressing the slope of a structure with rise to run. Using scale drawings.
		Shape and Spatial Sense
√	Measurement Conversions	Perform measurement conversions. For example, converting inches to millimetres or litres to gallons when fabricating a structure.
√	Areas, Perimeters, Volumes	Calculate areas. Calculate perimeters. Calculate volumes. For example, calculating the volume, circumference and diameter when building tanks, calculating the radius and circumference of pipes.
√	Geometry	Use geometry. For example, calculating angles for slings when rigging, measuring the distance between opposite corners on a square to ensure it is perfectly square, calculating the length of one side of a triangle.
√	Trigonometry	Use trigonometry. For example, calculating rise and run given the angle of ascent. Recognizing common angles. Drawing, sketching and forming common forms and figures. Using tables, schedules or other table-like text. Using graphical presentations.

b. How Calculations are Performed

- In their heads.
- Using a pen and paper.
- Using a calculator.

c. Measurement Instruments Used

- Time. For example, using a clock or watch.
- Distance or dimension. For example, using a tape measure, a ruler, a square, fillet gauge, builder's level, plumb bob.
- Temperature. For example, using a temperature gauge or a temp/heat stick.
- Pressure. For example, using a pressure gauge.
- Angles. For example, using a protractor level or tri-square.
- Use the SI (metric) measurement system.
- Using the imperial measurement system.

E. Oral Communication

Oral Communication

Tasks	Complexity Level	Examples
Typical	1 to 3	Welders: • give directions to truck drivers picking up and dropping off material. (1) • communicate with tool room staff to ask for tools, supplies and personal protective equipment. (1) • ask co-workers, for example an apprentice, other journeyperson welder, a pipefitter, or a millwright for assistance with a task such as lifting or to provide information. (1) • communicate with a partner about the size and fit of the pieces, and compare measurements and calculations when building a structure. (2) • contribute ideas about tasks and safety issues at production meetings. (2) • discuss work assignments with the supervisor to understand expectations. (2)
Most Complex	3	• may give informal presentations to students or to customer groups, if requested by management, to explain the set up of the operation and describe the projects taking place. (2) • coach apprentices by demonstrating and explaining the use of equipment such as drill presses, brake boards, cranes, and drill punch machinery. (3) • may explain welding designs to customers to help understand why structures were built in a certain way and appreciate the quality of the work. (3)

Modes of Communication Used

- In person.
- Using a telephone.
- Using specialized communications signals. For example, hand signals.

Environmental Factors Affecting Communication

Welders often work in noisy environments caused by machinery such as mobile equipment, grinders, hammers, sandblasters and moving metal. Because of the noise, welders wear earplugs for ear protection and use hand signals to communicate whenever possible, particularly from a distance. Welders are required to use the standard hand signals for rigging.

Oral Communication Summary

The symbol √ is explained in the Use of Symbols section.

	Purpose for Oral Communication (Part I)					
Type	**To greet**	**To take messages**	**To provide /receive information, explanation, direction**	**To seek, obtain information**	**To co-ordinate work with that of others**	**To reassure, comfort**
Listening (little or no interaction)						
Speaking (little or no interaction)						
Interact with co-workers			√	√	√	
Interact with those you supervise or direct			√		√	
Interact with supervisor/ manager			√		√	
Interact with peers and colleagues from other organization						
Interact with customers/ clients/ public			√			
Interact with suppliers, servicers			√			
Participate in group discussion					√	
Present information to a small group			√			
Present information to a large group			√			

The symbol √ is explained in the Use of Symbols section.

	Purpose for Oral Communication (Part II)					
Type	**To discuss (exchange information, opinions)**	**To persuade**	**To facilitate, animate**	**To instruct, instill understanding, knowledge**	**To negotiate, resolve conflict**	**To entertain**
Listening (little or no interaction)						
Speaking (little or no interaction)						
Interact with co-workers	√			√		
Interact with those you supervise or direct	√			√		
Interact with supervisor/ manager	√			√		
Interact with peers and colleagues from other organization						
Interact with customers/ clients/ public	√			√		
Interact with suppliers, servicers	√					
Participate in group discussion	√					
Present information to a small group						
Present information to a large group						

F. Thinking Skills

1. Problem Solving

Problem Solving

Tasks	Complexity Level	Examples
Typical	1 to 2	Welders: • receive blueprints with measurements that do not add up. Welders report the discrepancy to the supervisor, draftsperson or engineer. This may result in the job being placed on hold until the discrepancies have been studied and reconciled. (1) • have to take projects apart when an incorrectly sized piece (e.g., flange) has been inserted. The piece may need to be cut out and sent back to the manufacturer for re-cutting. (1) • follow procedures that are inaccurate, resulting in a structure's pieces not fitting together properly. If it is a minor problem, the welder works with the supervisor to decide on a solution. (1)
Most Complex	2	• have to work in difficult conditions such as bad weather or awkward locations, in particular welding above the head and at the bottom or back of a structure. In order to complete the work expected by the client or supervisor, welders need to generate unique solutions depending on the situation and structure such as organizing suitable protection. (2) • solve problems with distortion caused by unequal expansion and contraction of materials during the welding process. Welders must decide how to address the weld sequence to minimize distortion by considering factors such as heat input, the configuration of the structure, and the type of material being used. (2)

2. Decision Making

Decision Making

Tasks	Complexity Level	Examples
Typical	1 to 2	Welders: • decide on the best location to place rigging equipment when preparing a load for transportation. (1) • upon receiving a work assignment, decide whether they have enough information to start the task immediately or whether they need to gather more information first. (2)
Most Complex	2	• decide on the most efficient use of materials during construction to minimize waste. (2) • may decide on the best way to approach a job in consultation with supervisor and any work partners, such as the best way to construct a piping system at a gas plant. (2) • decide when and how to control the temperature during the welding process to avoid metallurgical problems, in particular cracking. The knowledge needed to make these decisions is acquired through training and by observing and remembering the performance of metals during previous welds. (2)

3. Critical Thinking

Critical Thinking information was not collected for this profile.

4. Job Task Planning and Organizing

Job Task Planning and Organizing

Complexity Level	Description
2	Own job planning and organizing • Generally, welders are assigned work by their supervisor who informs them of the priority of tasks. There is frequent resetting of priorities by the supervisor. For example, it is common for a welder to be called away from one project to work on another. • Welders are responsible for organizing their work and setting up the work area properly. They must gather materials and equipment required for the procedure and set up the equipment following established steps. • Although approximately 80% of welders' work is done independently, they need to coordinate their work with others, including apprentice welders, fitters and other trades people. In a plant or shop setting, welders must share equipment such as cranes, saws and grinders with co-workers. If the equipment is not available when desired, the welder needs to work on alternative tasks until the equipment is available.

5. Significant Use of Memory

Examples

- memorize measurements for repeated welds as specified on the blueprint for the duration of a project.
- remember the capability of various types of welding rods and the best technique to use with each type.
- remember how materials perform and react under the application of heat. For example, welders must remember how much to allow for weld metal contraction.
- remember the location of co-workers and hazards, such as mobile equipment and loads being transported, for their own safety and the safety of their co-workers.
- memorize the sequence of steps for setting up welding equipment.
- recall welding procedures that are frequently used.

6. Finding Information

Finding Information

Tasks	Complexity Level	Examples
Typical	1 to 2	Welders: • receive clarification about work assignments, such as procedures and material to be used, by asking supervisors. (1) • identify the type of electrode by looking at the specifications printed on its side or packaging. (1) • look up specifications for welding procedures on data sheets developed by the engineering department. These specifications are based on code. (2) • read company policy manuals to determine employee benefits and responsibilities. (2) • refer to safety manuals and Workplace Hazardous Materials Information System (WHMIS) materials to learn about safe work procedures. (2)

G. Working with Others

Participation in Supervisory or Leadership Activities

- Participate in formal discussions about work processes or product improvement.
- Have opportunities to make suggestions on improving work processes.
- Monitor the work performance of others.
- Inform other workers or demonstrate to them how tasks are performed.
- Orient new employees.
- Make hiring recommendations.
- Assign routine tasks to other workers.
- Assign new or unusual tasks to other workers.
- Identify training that is required by, or would be useful for, other workers.

H. Computer Use

Computer Use

Tasks	Complexity Level	Examples
Typical Most Complex	2 2	Welders: • input data and operate plasma cutting machines, orbital welders and other computer controlled equipment. (2)

Computer Use Summary

- Other

I. Continuous Learning

How Learning Occurs

Learning may be acquired:

- As part of regular work activity.
- From co-workers.
- Through training offered in the workplace.
- Through reading or other forms of self-study
  - at work.
  - on worker's own time.
  - using materials available through work.
  - using materials obtained through a professional association or union.
  - using materials obtained on worker's own initiative.
- Through off-site training
  - during working hours at no cost to the worker.
  - partially subsidized.
  - with costs paid by the worker.

J. Other Information

In addition to collecting information for this Essential Skills Profile, our interviews with job incumbents also asked about the following topics.

Physical Aspects
The work of a welder requires extensive movement and sometimes standing in the same position for extended periods of time. Welders are also required to hold other positions for extended periods such as reaching up, crouching, and lying on the ground. They often stand on concrete surfaces, placing additional stress on their feet and legs.

Attitudes
The welders interviewed felt that individuals in their occupation must be patient and focussed. This can be challenging when the work is routine, but a loss of focus results in substandard welds. Patience is also required to master certain types of welds. For safety purposes, it is very important that welders are aware of their surroundings. They must be team players and able to get along with others.

Future Trends Affecting Essential Skills
Continuous learning will become increasingly important in order for welders to keep current with advances in technology resulting in new materials, equipment and welding techniques. Information finding, reading and continuous learning will be done increasingly through electronic media as manufacturers and authorities make increasing use of the Internet and CD-ROMs to distribute information.

K. Notes

This profile is based on interviews with job incumbents across Canada and validated through consultation with industry experts across the country.
For information on research, definitions, and scaling processes of Essential Skills Profiles, please consult the Readers' Guide to Essential Skills Profiles (http://www.hrsdc.gc.ca/eng/jobs/les/profiles/readersguide.shtml).