PROGRAM PROGRAMME
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Red Seal Occupational Standard

Welder

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Foreword

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the Red Seal standard for the Welder trade.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. Employment and Social Development Canada (ESDC) funds the Red Seal Program, which, under the guidance of the CCDA, develops a national occupational standard for each of the Red Seal trades.

Standards have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and assessment tools for apprenticeship and certification authorities;
- to develop common tools for apprenticeship on-the-job and technical training in Canada;
- to facilitate the mobility of apprentices and skilled workers in Canada;
- to supply employers, employees, associations, industries, training institutions and governments with occupational standards.

Any questions, comments, or suggestions for changes, corrections, or revisions to this standard or any of its related products may be forwarded to:

Trades and Apprenticeship Division
Apprenticeship and Sectoral Initiatives Directorate
Employment and Social Development Canada
140 Promenade du Portage, Phase IV
Gatineau, Quebec K1A 0J9

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Brad Harder	British Columbia
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Dale McGavin	Ontario
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Doryan Unrau	Manitoba
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This standard was prepared by the Apprenticeship and Sectoral Initiatives Directorate of ESDC. The coordinating, facilitating and processing of this standard were undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of Newfoundland and Labrador, the host jurisdiction for this trade.

Structure of the Occupational Standard

This standard contains the following sections:

Methodology: an overview of the process for development, review, validation and weighting of the standard

Description of the Welder Trade: an overview of the trade's duties, work environment, job requirements, similar occupations and career progression

Trends in the Welder Trade: some of the trends identified by industry as being the most important for workers in this trade

Skills for Success Summary: an overview of how each of the skills for success (formerly called essential skills) is applied in this trade

Industry Expected Performance: description of the expectations regarding the level of performance of the tasks, including information related to specific codes, regulations and standards that must be observed

Language Requirements: description of the language requirements for working and studying in this trade in Canada

Pie Chart of Red Seal Examination Weightings: a graph which depicts the national percentages of exam questions assigned to the major work activities

Task Matrix and Weightings: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard and the national percentages of exam questions assigned to the major work activities and tasks

Harmonization of Apprenticeship Training: the aspects of apprenticeship training that participating provinces and territories have agreed upon to substantively align apprenticeship systems across Canada

Major Work Activity (MWA): the largest division within the standard that is comprised of a distinct set of trade activities

Task: distinct actions that describe the activities within a major work activity

Task Descriptor: a general description of the task

Sub-task: distinct actions that describe the activities within a task

Skills:

Performance Criteria: description of the activities that are done as the sub-task is performed

Evidence of Attainment: proof that the activities of the sub-task meet the expected performance of a tradesperson who has reached journeyperson level

Range of Variables: elements and examples (not all inclusive) that provide a more in-depth description of a term used in the performance criteria and evidence of attainment

Knowledge:

Learning Outcomes: describes what should be learned relating to a sub-task while participating in technical or in-school training

Learning Objectives: topics to be covered during technical or in-school training in order to meet the learning outcomes for the sub-task

Range of Variables: elements and examples (not all inclusive) that provide a more in-depth description of a term used in the learning outcomes and learning objectives

Appendix A – Acronyms: a list of acronyms used in the standard with their full name

Appendix B – Tools and Equipment / Outils et équipement: a bilingual non-exhaustive list of tools and equipment used in this trade

Appendix C – Glossary / Glossaire: bilingual definitions or explanations of selected technical terms used in the standard

Methodology

Development of the Standard

A draft standard is developed by a broad group of trade representatives, including tradespeople, instructors and employers at a National Workshop led by a team of facilitators. This draft standard breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

Harmonization of Apprenticeship Training

An analysis of all provinces' and territories' apprenticeship programs is performed and recommendations are made on harmonizing the name of the trade, the hours of training required and the number of levels of training. Provinces and territories consult with their respective industry stakeholders on these elements and revisions are discussed until consensus is reached. Following the development of the workshop draft of the RSOS, participants discuss and come to consensus on the sequence of training topics, as expressed in the new standard. Their sequencing recommendations are reviewed by stakeholders in participating provinces and territories and further discussions are convened to reach consensus and to identify any exceptions.

Online Survey

Stakeholders are asked to review and validate the activities described in the new standard via an online survey. These stakeholders are invited to participate in this consultation through apprenticeship authorities, as well as national stakeholder groups.

Draft Review

The RSOS development team forwards a copy of the standard to provincial and territorial authorities who consult with industry representatives to review it. Their recommendations are assessed and incorporated into the standard.

Validation and Weighting

Participating provinces and territories also consult with industry to validate and weight the document for the purpose of planning the makeup of the Red Seal Interprovincial Examination for the trade. They validate and weight the major work activities (MWA), tasks and sub-tasks, of the standard as follows:

MWA	Each jurisdiction assigns a percentage of questions to each MWA for an examination that would cover the entire trade.
Tasks	Each jurisdiction assigns a percentage of exam questions to each task within a MWA.
Sub-tasks	Each jurisdiction indicates, with a "yes" or "no", whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

The results of this exercise are submitted to the RSOS development team who then analyzes the data and incorporates it into the document. The RSOS provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for MWA and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

The validation of the RSOS is used to identify common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions' industry performs a sub-task, it shall be considered common core. Interprovincial Red Seal Examination questions are limited to the common core sub-tasks identified through this validation process.

Definitions for Validation and Weighting

yes	sub-task performed by qualified workers in the occupation in that province or territory
no	sub-task not performed by qualified workers in the occupation in that province or territory
NV	standard Not Validated by that province or territory
ND	trade Not Designated in a province or territory
Not Common Core (NCC)	sub-task, task or MWA performed less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
National Average %	average percentage of questions assigned to each MWA and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

NL	Newfoundland and Labrador
NS	Nova Scotia
PE	Prince Edward Island
NB	New Brunswick
QC	Quebec
ON	Ontario
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
NT	Northwest Territories
YT	Yukon Territory
NU	Nunavut

Description of the Welder Trade

“Welder” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by welders.

Welders permanently join pieces of metal by applying heat, using filler metal or fusion processes. They join parts being manufactured, build structures, repair damaged or worn parts and apply wear surfaces. They use various welding processes to join structural steel and metal in vessels, piping and other components. They also use various cutting and gouging processes as well as fabricate parts, tools, machines and equipment used in the construction and manufacturing industries. They must be knowledgeable in weld faults (discontinuities), how they happen and how to correct them.

Welders may specialize in certain types of welding such as custom fabrication, ship building and repair, bridge building and repairs, marine infrastructure, aerospace, pressure vessels, pipeline, structural welding, and machinery and equipment repair. There is a large diversity of materials used and products manufactured, resulting in a greater range of processes and specializations.

Welders may be self-employed contractors or be employed by companies such as fabrication shops, steel and platform manufacturers, refineries, mechanical contractors, transportation contractors (heavy machinery, aircraft, shipbuilding, railcar repair), and specialized welding shops. Their work may be performed outdoors or indoors, on land or in water, and travel may be required to jobs in remote locations.

In order to meet high quality standards, welders require attributes such as good mechanical ability, manual dexterity, good vision, excellent hand-eye coordination, and the ability to concentrate on detail work. They should be able to work independently and as part of a team. They also require the ability to work efficiently and accurately, to visualize a finished product, to reason logically and to understand metallurgy. They must be able to read and understand fabrication drawings and a variety of different prints depending on the industry.

Occupational hazards in this trade include: sparks, gases, hazardous fumes, burns, heavy lifting, repetitive stress and exposure to ultra-violet and infra-red radiation. Environmental conditions may include working at heights, in confined spaces, in trenches and in extreme temperatures.

With experience, welders may advance to positions such as lead hand, welding supervisor, welding inspector, welding engineer and project manager.

This standard recognizes similarities or overlaps with the work of industrial mechanics (millwrights), sheet metal workers, steamfitters/pipefitters, metal fabricators (fitters), ironworkers and boilermakers. With additional training, welders can transfer their skills to these related trades.

Trends in the Welder Trade

Technology, Tools and Equipment

Modern tools are well engineered with ergonomics and safety in mind. Cordless (self-contained power supply) welding machines have been developed and are being introduced to the market allowing for various sources of battery power.

There are increases in the use of computerized welding equipment, especially programmable welding stations with multiple integrated processes. Advanced user interfaces and software updates allow for finer adjustments and user control. They decrease user error by ensuring pre set parameters are followed. With the industry being more and more automated and streamlined, welders are required to have an increased comfort in working with technology.

Robotics and automated welding are being used for a greater variety of applications such as large scale manufacturing as they become more affordable and smaller in size.

AC aluminum pulse gas metal arc welding (GMAW) has features that are not available with DC GMAW welding. This process allows for increased travel speed and deposition rates, improves gap bridging and reduces chance of burn through.

Products/Materials

Having a good understanding of the various classifications of steel and consumables is becoming more important than ever. Demand is increasing for the welding of stainless steel and aluminum, among others. More ornamental metals are being used.

Health and Safety

Various studies have shown hazards related to the exposure to carcinogens in a variety of welding products such as grinding discs.

With more alloy work, there is a greater need for respiratory and ventilation controls. There is a better understanding today of the effects of hexavalent chrome and manganese and the potential risk to human organs and as a result, control of welding fumes is more stringent. There are improved breathing protection masks and full respirators. Increasingly, welders are using helmets (such as PAPR) that have a filtered air supply. Workplaces have seen improvements in fume extraction techniques and systems.

To address health and safety issues, specific personnel are appointed and trained to support employees. Training such as confined space work, work at heights, WHMIS and overhead crane operation are now part of the training that most welders must have.

Environmental

There are number of environmental hazards and issues that are important in welding. Awareness of these hazards and how to mitigate and prevent them are often at the project management level of work, but the welding community should also be a part of efforts to improve practices. For example, there needs to be improved awareness of harmful emissions produced through consumables and how to manage disposal of rods/wire and emitted gases. Increasingly, clients are requesting site-specific and corporate plans and actions.

Legislative and Regulatory

There have been revisions and evolution in legislation and regulations regarding the transport, use and safe storage of compressed gases and their containment cylinders. For welders who also have to go to the construction site, they must be up-to-date on training and certifications required in the field.

The industry is heavily regulated regarding the scope of work. More and more, small welding shops need to employ project management employees knowledgeable in a multitude of legislative and regulatory mandates.

Skills for Success Summary

Skills for Success are needed in a quickly changing world for work, learning and life. They are foundational for building other skills and important for effective social interaction. Everyone benefits from having these skills as they help individuals get a job, progress at their current job and change jobs. They also help individuals become active members of their community and succeed in learning.

Through extensive research and consultations, the Government of Canada launched the new Skills for Success model renewing the previous Essential Skills framework to better reflect the needs of the current and future labour market.

The summary presented here is based on existing Essential Skills profiles and will be updated to align with the new Skills for Success model over time.

Reading

Welders read documents to understand and learn. They read WHMIS material to find out how to handle hazardous products, as welsl as equipment and safety manuals to understand safe operating procedures. They also read and interpret complex information found in drawings, codes and regulations.

Document Use

Welders refer to checklists to follow proper work procedures and to track the progress of projects. They interpret the significance of information found on various documents. They look for safety information on signs and project status on tags. They observe colours on pipes, lines and metals to determine their contents or grade. They refer to markings such as stamps, metal plates, or tags. They complete forms and reports such as invoices, time sheets or daily logs to record information. They interpret symbols and numbers found on drawings to determine material requirements and measurements as well as the welding process to be used and the type, size, location and position of welds. They also review engineering notes found on drawings, or welding procedures specifications (WPS) and welding procedures data sheets (WPDS).

Writing

For the most part, welders write minimal text. They fill in information in invoices, reports, time sheets and daily logs. They may have to complete accident and incident reports or write safety guidelines.

Oral Communication

Welders communicate with co-workers and others daily to give directions, ask for assistance, provide information and guidance, and discuss work assignments. They may give informal presentations or explain welding designs to customers. They may also coach and mentor apprentices by demonstrating and explaining work procedures and expectations.

Welders often work in noisy environments caused by moving metal and machinery such as mobile equipment, grinders, hammers and sandblasters, which affects communication. Therefore, welders use hand signals to communicate whenever necessary, particularly from a distance.

Numeracy

Welders measure degrees of angles, lengths of pipe and elevations. They use various formulas to calculate how to get the maximum number of pieces out of a length of pipe, the dimensions of structural members, the volume, diameter and circumferences of tanks when fabricating pieces for them, and offsets. They may work with the metric and imperial measurement systems and therefore must be able to convert between the two systems. Welders also use numerical estimation to estimate the quantity of consumables required, the weight of a load based on its size and density, and the cost of work based on material and labour requirements.

Thinking

Welders use problem solving skills to identify discrepancies in drawings. They troubleshoot problems with equipment and generate unique solutions depending on the situation.

Welders use decision making skills to decide whether they have enough information to start the task immediately or whether they need to gather more information first. They decide on the most efficient use of materials and how to control the temperature during the welding process to avoid metallurgical problems. They may also decide on the best way to approach a job in consultation with their supervisor and any work partners.

Welders use planning skills to organize and set up their work area, gather materials and equipment, and work on alternative tasks if equipment is not available.

Working with Others

Welders mostly work independently within a team environment, which includes other welders, supervisors and other tradespeople such as steamfitters/pipefitters and metal fabricators (fitters), to plan work, confirm calculations and to schedule the sharing of equipment. They may coach and receive assistance from apprentices. They may also be partnered with someone from another trade, such as a steamfitter/pipefitter or metal fabricator (fitter), to coordinate their tasks on projects so that steps are completed in the correct order.

Digital Technology

Welders may use computers for research, data entry and viewing trade documents. They also use electronic communication software to communicate with customers and suppliers.

Continuous Learning

Welders may attend information and training seminars hosted by suppliers about new products. Employers also provide training specific to their company such as company policies, confined space entry, helicopter safety and H_2S Alive. Welders must upgrade their knowledge and skills on an ongoing basis because of new innovations in consumables, and welding applications and processes. They may learn by researching technical information on the Internet, participating in formal training opportunities or informally on the job.

Welders are required by various codes to recertify or upgrade their qualifications within a specific period of time. Study and practice may be required in preparation for these tests.

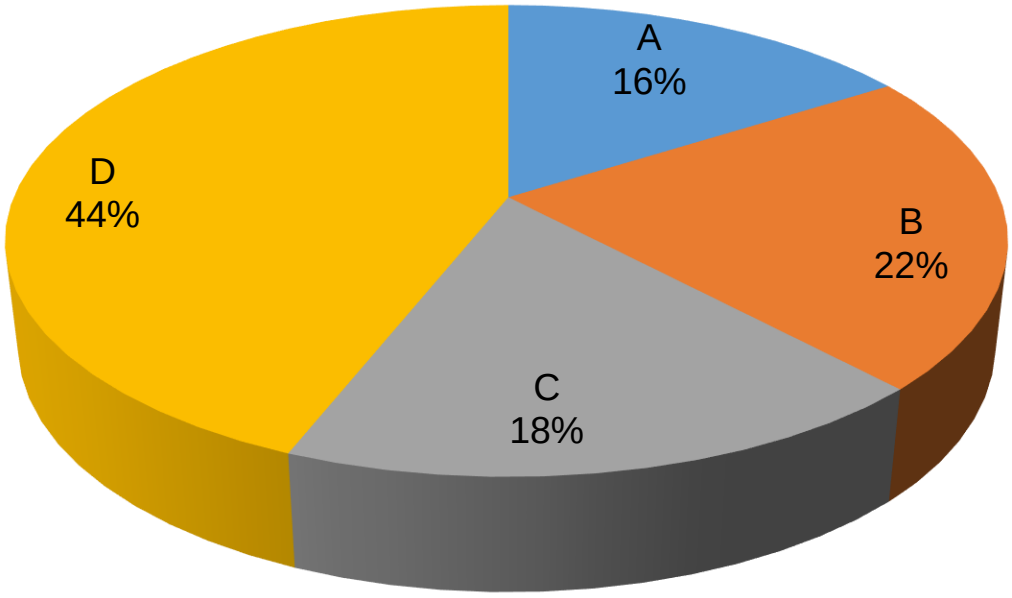
Industry Expected Performance

All tasks must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected and observed. Work should be performed efficiently and to a high quality without material waste or environmental damage. All requirements of employers, engineers, designers, manufacturers, clients and quality control policies must be met. At a journeyperson level of performance, all tasks must be done with minimal direction and supervision. As a journeyperson progresses in their career there is an expectation they continue to upgrade their skills and knowledge to maintain pace with industry and promote continuous learning in their trade through mentoring of apprentices.

Language Requirements

It is expected that journeypersons are able to understand and communicate in either English or French, which are Canada's official languages. English or French are the common languages of business as well as languages of instruction in apprenticeship programs.

Pie Chart of Red Seal Examination Weightings



Major Work Activity A	Performs common occupational skills
Major Work Activity B	Performs layout and fabrication of components for welding
Major Work Activity C	Performs cutting and gouging
Major Work Activity D	Performs welding processes

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the Tasks. The Interprovincial examination for this trade has 125 questions.

Welder
Task Matrix and Weightings

A – Performs common occupational skills — 16%

Task A-1 **Maintains tools and equipment** **25%**	**A-1.01 Maintains hand, power, layout and measuring tools**	**A-1.02 Maintains stationary machinery**	**A-1.03 Maintains thermal cutting equipment**
	A-1.04 Maintains welding equipment		
Task A-2 **Uses access and material handling equipment** **15%**	**A-2.01 Uses access equipment**	**A-2.02 Uses material handling equipment**	
Task A-3 **Performs safety-related activities** **25%**	**A-3.01 Performs hazard assessments**	**A-3.02 Maintains safe work environment**	**A-3.03 Uses personal protective equipment (PPE) and safety equipment**
Task A-4 **Organizes work** **15%**	**A-4.01 Uses documentation and reference material**	**A-4.02 Interprets drawings and welding symbols**	**A-4.03 Plans job tasks**
	A-4.04 Organizes materials		

Task A-5 **Performs routine trade activities** **28%**	**A-5.01 Performs quality inspection**	**A-5.02 Marks welds, materials and parts**	**A-5.03 Controls temperature of weldments**
	A-5.04 Stores welding consumables and gas cylinders	**A-5.05 Selects welding processes and power source**	**A-5.06 Performs equipment start-up and shut-down**
	A-5.07 Finishes final product		
Task A-6 **Uses communication and mentoring techniques** **2%**	**A-6.01 Uses communication techniques**	**A-6.02 Uses mentoring techniques**	

B – Performs layout and fabrication of components for welding — 22%

Task B-7 **Performs layout** **44%**	**B-7.01 Develops templates**	**B-7.02 Transfers dimensions from drawings to materials**	
Task B-8 **Fabricates components** **56%**	**B-8.01 Prepares materials**	**B-8.02 Fits components for welding**	**B-8.03 Assembles components**

C – Performs cutting and gouging — 18%

Task C-9 **Uses tools and equipment for non-thermal cutting and grinding** **25%**	**C-9.01 Selects cutting and grinding tools**	**C-9.02 Cuts using stationary power tools**	**C-9.03 Cuts using shears and ironworkers**
	C-9.04 Cuts using hand tools	**C-9.05 Cuts using portable power tools**	

Task C-10 **Uses oxy-fuel gas cutting (OFC) process for cutting and gouging** **30%**	**C-10.01 Selects OFC gas and equipment**	**C-10.02 Sets up OFC equipment**	**C-10.03 Sets operating parameters for OFC equipment**
	C-10.04 Performs cut and gouge using OFC equipment		
Task C-11 **Uses plasma arc cutting (PAC) process for cutting and gouging** **26%**	**C-11.01 Selects PAC equipment and consumables**	**C-11.02 Sets up PAC equipment**	**C-11.03 Sets operating parameters for PAC equipment**
	C-11.04 Performs cut and gouge using PAC equipment		
Task C-12 **Uses air carbon arc cutting (CAC-A) process for cutting and gouging** **19%**	**C-12.01 Selects CAC-A equipment and consumables**	**C-12.02 Sets up CAC-A equipment**	**C-12.03 Sets operating parameters for CAC-A equipment**
	C-12.04 Performs cut and gouge using CAC-A equipment		

D – Performs welding processes — 44%

Task D-13 **Welds using shielded metal arc welding (SMAW) process** **33%**	**D-13.01 Selects SMAW equipment and consumables**	**D-13.02 Sets up SMAW equipment**	**D-13.03 Sets operating parameters for SMAW**
	D-13.04 Performs weld using SMAW equipment		

Task D-14 **Welds using flux cored arc welding (FCAW), metal cored arc welding (MCAW) and gas metal arc welding (GMAW) processes** **34%**	**D-14.01 Selects FCAW, MCAW and GMAW gas, equipment and consumables**	**D-14.02 Sets up FCAW, MCAW and GMAW equipment**	**D-14.03 Sets operating parameters for FCAW, MCAW and GMAW**
	D-14.04 Performs weld using FCAW, MCAW and GMAW equipment		
Task D-15 **Welds using gas tungsten arc welding (GTAW) process** **24%**	**D-15.01 Selects GTAW gas, equipment and consumables**	**D-15.02 Sets up GTAW equipment**	**D-15.03 Sets operating parameters for GTAW**
	D-15.04 Performs weld using GTAW equipment		
Task D-16 **Welds using submerged arc welding (SAW) process** **9%**	**D-16.01 Selects SAW equipment and consumables**	**D-16.02 Sets up SAW equipment**	**D-16.03 Sets operating parameters for SAW**
	D-16.04 Performs weld using SAW equipment		

Harmonization of Apprenticeship Training

Provincial and territorial apprenticeship authorities are each responsible for their respective apprenticeship programs. In the spirit of continual improvement, and to facilitate mobility among apprentices in Canada, participating authorities have agreed to work towards harmonizing certain aspects of their programs where possible. After consulting with their stakeholders in the trade, they have reached consensus on the following elements. Note that implementation of these elements may vary from jurisdiction to jurisdiction, depending on their own circumstances. For more information on the implementation in any province and territory, please contact that jurisdiction's apprenticeship authority.

1. Trade name

The official Red Seal name for this trade is Welder.

2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for this trade is three (3).

3. Total Training Hours

The total hours of training, including both on-the-job and in-school training for this trade is 5400.

4. Sequencing Topics and Related Sub-tasks

The topic titles in the table below are placed in a column for each apprenticeship level for technical training. Each topic is accompanied by the sub-tasks and their reference number. The topics in the grey shaded cells represent those that are covered "in context" with other training in the subsequent years.

Level 1	Level 2	Level 3
	Context	Context
	Tools and Equipment	Tools and Equipment
	Safety-Related Activities	Safety-Related Activities
Tools and Equipment 1.01 Maintains hand, power, layout and measuring tools 1.02 Maintains stationary machinery 1.03 Maintains thermal cutting equipment 1.04 Maintains welding equipment	**Tools and Equipment** 1.04 Maintains welding equipment	**Tools and Equipment** 1.04 Maintains welding equipment
Access and Material Handling Equipment 2.01 Uses access equipment 2.02 Uses material handling equipment		
Safety-Related Activities 3.01 Performs hazard assessments 3.02 Maintains safe work environment 3.03 Uses personal protective equipment (PPE) and safety equipment		

Level 1	Level 2	Level 3
Organizes Work 4.01 Uses documentation and reference material 4.02 Interprets drawings and welding symbols 4.04 Organizes materials	**Organizes Work** 4.01 Uses documentation and reference material 4.02 Interprets drawings and welding symbols 4.03 Plans job task 4.04 Organizes materials	
Routine Trade Activities 5.01 Performs quality inspection 5.02 Marks welds, materials and parts 5.03 Controls temperature of weldments 5.04 Stores welding consumables and gas cylinders 5.05 Selects welding processes and power source 5.06 Performs equipment start-up and shutdown 5.07 Finishes final product	**Routine Trade Activities** 5.01 Performs quality inspection 5.02 Marks welds, materials and parts 5.03 Controls temperature of weldments 5.04 Stores welding consumables and gas cylinders 5.05 Selects welding processes and power source 5.06 Performs equipment start-up and shutdown 5.07 Finishes final product	**Routine Trade Activities** 5.01 Performs quality inspection 5.02 Marks welds, materials and parts 5.03 Controls temperature of weldments 5.04 Stores welding consumables and gas cylinders 5.05 Selects welding processes and power source 5.06 Performs equipment start-up and shutdown 5.07 Finishes final product
Communication Techniques 6.01 Uses communication techniques		**Mentoring Techniques** 6.02 Uses mentoring techniques
Performs Layout 7.01 Develops templates 7.02 Transfers dimensions from drawings to materials	**Performs Layout** 7.01 Develops templates 7.02 Transfers dimensions from drawings to materials	
Fabricates Components 8.01 Prepares materials 8.02 Fits components or welding 8.03 Assembles components	**Fabricates Components** 8.01 Prepares materials 8.02 Fits components or welding 8.03 Assembles components	
Tools and Equipment for Non-Thermal Cutting and Grinding 9.01 Selects cutting and grinding tools 9.02 Cuts using stationary power tools 9.03 Cuts using shears and ironworkers 9.04 Cuts using hand tools 9.05 Cuts using portable power tools		
Oxy-fuel Gas Cutting (OFC) Process for Cutting and Gouging 10.01 Selects OFC gas and equipment 10.02 Sets up OFC equipment 10.03 Sets operating parameters for OFC equipment 10.04 Performs cut and gouge using OFC equipment		

Level 1	Level 2	Level 3
Plasma Arc Cutting (PAC) Process for Cutting and Gouging 11.01 Selects PAC equipment and consumables 11.02 Sets up PAC equipment 11.03 Sets operating parameters for PAC equipment 11.04 Performs cut or gouge using PAC equipment		
Air Carbon Arc Cutting (CAC-A) Process for Cutting and Gouging 12.01 Selects CAC-A equipment and consumables 12.02 Sets up CAC-A equipment 12.03 Sets operating parameters for CAC-A equipment 12.04 Performs cut and gouge using CAC-A equipment		
Shielded Metal Arc Welding (SMAW) Process 13.01 Selects SMAW equipment and consumables 13.02 Sets up SMAW equipment 13.03 Sets operating parameters for SMAW 13.04 Performs weld using SMAW equipment	**Shielded Metal Arc Welding (SMAW) Process** 13.01 Selects SMAW equipment and consumables 13.02 Sets up SMAW equipment 13.03 Sets operating parameters for SMAW 13.04 Performs weld using SMAW equipment	**Shielded Metal Arc Welding (SMAW) Process** 13.01 Selects SMAW equipment and consumables 13.02 Sets up SMAW equipment 13.03 Sets operating parameters for SMAW 13.04 Performs weld using SMAW equipment
Flux Cored Arc Welding (FCAW), Metal Cored Arc Welding (MCAW) and Gas Metal Arc Welding (GMAW) Processes 14.01 Selects FCAW, MCAW and GMAW gas, equipment and consumables 14.02 Sets up FCAW, MCAW and GMAW equipment 14.03 Sets operating parameters for FCAW, MCAW and GMAW 14.04 Performs weld using FCAW, MCAW and GMAW equipment	**Flux Cored Arc Welding (FCAW), Metal Cored Arc Welding (MCAW) and Gas Metal Arc Welding (GMAW) Processes** 14.01 Selects FCAW, MCAW and GMAW gas, equipment and consumables 14.02 Sets up FCAW, MCAW and GMAW equipment 14.03 Sets operating parameters for FCAW, MCAW and GMAW 14.04 Performs weld using FCAW, MCAW and GMAW equipment	**Flux Cored Arc Welding (FCAW), Metal Cored Arc Welding (MCAW) and Gas Metal Arc Welding (GMAW) Processes** 14.01 Selects FCAW, MCAW and GMAW gas, equipment and consumables 14.02 Sets up FCAW, MCAW and GMAW equipment 14.03 Sets operating parameters for FCAW, MCAW and GMAW 14.04 Performs weld using FCAW, MCAW and GMAW equipment
	Gas Tungsten Arc Welding (GTAW) Process 15.01 Selects GTAW gas, equipment and consumables 15.02 Sets up GTAW equipment 15.03 Sets operating parameters for GTAW 15.04 Performs weld using GTAW equipment	**Gas Tungsten Arc Welding (GTAW) Process** 15.01 Selects GTAW gas, equipment and consumables 15.02 Sets up GTAW equipment 15.03 Sets operating parameters for GTAW 15.04 Performs weld using GTAW equipment

Level 1	Level 2	Level 3
	Submerged Arc Welding (SAW) Process **16.01 Selects SAW equipment and consumables** **16.02 Sets up SAW equipment** **16.03 Sets operating parameters for SAW** **16.04 Performs weld using SAW equipment**	**Submerged Arc Welding (SAW) Process** **16.01 Selects SAW equipment and consumables** **16.02 Sets up SAW equipment** **16.03 Sets operating parameters for SAW** **16.04 Performs weld using SAW equipment**

Major Work Activity A
Performs Common Occupational Skills

Task A-1 Maintains tools and equipment

Task Descriptor

Welders must maintain tools and equipment in order to keep them in safe working condition.

A-1.01 Maintains hand, power, layout and measuring tools

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task
A-1.01.02P	identify maintenance needs	maintenance needs are identified according to tool condition and manufacturers' specifications
A-1.01.03P	identify worn, damaged and defective tools and remove from service	worn, damaged and defective tools are identified and removed from service
A-1.01.04P	sharpen ***striking tools*** and repair defective tooling heads	***striking tools*** are sharpened and defective tooling heads are repaired
A-1.01.05P	identify and sharpen twist drill bits	dull and damaged cutting edges on twist drill bits are identified and sharpened
A-1.01.06P	clean and lubricate tools after use	tools are cleaned and lubricated after use
A-1.01.07P	check accuracy and calibrate layout and measuring tools	layout and measuring tools' accuracy is checked and tools are calibrated
A-1.01.08P	store hand, power, layout and measuring tools	hand, power, layout and measuring tools are stored according to manufacturers' recommendations
A-1.01.09P	lubricate pneumatic tools and ensure air supply is dry and clean	pneumatic tools are lubricated and air supply is dry and clean according to manufacturers' specifications

A-1.01.10P	inspect safety guards, cords, switches, connectors and hoses	safety guards, cords, switches, connectors and hoses are inspected for damage and defects
A-1.01.11P	check fluids in hydraulic tools	fluids in hydraulic tools are checked and topped up if required

Range of Variables

striking tools include: chipping hammers, chisels, punches

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.01.01L	demonstrate knowledge of hand, power, layout and measuring tools, their characteristics, applications and operation	identify hand tools, and describe their characteristics and applications
		identify electric, pneumatic, and hydraulic power tools and attachments, and describe their characteristics and applications
		identify layout and measuring tools, and describe their characteristics and applications
		identify ***lubricants***, and describe their characteristics and applications
		describe operating principles of hand, power, layout and measuring tools
		identify and interpret information found in manufacturers' specifications pertaining to maintenance of hand, power, layout and measuring tools
A-1.01.02L	demonstrate knowledge of procedures to maintain and store hand, power, layout and measuring tools	identify tools and equipment used to maintain hand, power, layout and measuring tools, and describe their procedures for use
		identify ***hazards***, and describe safe work practices when maintaining hand, power, layout and measuring tools
		describe procedures to maintain hand, power, layout and measuring tools
		describe procedures to store hand, power, layout and measuring tools
		describe procedures to control waste and recycle hand, power, layout and measuring tools
		describe procedures to inspect hand, power, layout and measuring tools for damage and defects

Range of Variables

lubricants include: grease, gear oil, hydraulic oil, cutting fluids
hazards include: particulate projection, cuts, chemical burns, electrocution

A-1.02 Maintains stationary machinery

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.02.01P	lock out/tag out (LOTO) ***stationary machinery***	***stationary machinery*** is locked and tagged out prior to servicing
A-1.02.02P	identify maintenance needs	maintenance needs are identified according to tool condition and manufacturers' specifications
A-1.02.03P	clean ***stationary machinery*** and remove ***debris***	***stationary machinery*** is cleaned, and ***debris*** is removed to keep work surface functional and safe
A-1.02.04P	lubricate ***stationary machinery***	***stationary machinery*** is lubricated according to manufacturers' specifications
A-1.02.05P	inspect and top up coolant reservoir	coolant reservoir is inspected and topped up according to manufacturers' specifications
A-1.02.06P	inspect and replace ***filters***	***filters*** in stationary machines are inspected and replaced according to manufacturers' specifications
A-1.02.07P	inspect and adjust belt tension	belt tension is inspected and adjusted according to manufacturers' specifications
A-1.02.08P	ensure guards, shielding and safety devices are in place	guards, shielding and safety devices are in place according to manufacturers' recommendations
A-1.02.09P	adjust tool rests on pedestal grinders and other rotating equipment	tool rests on pedestal grinders and other rotating equipment are adjusted according to jurisdictional and Occupational Health and Safety (OH&S) regulations
A-1.02.10P	dress and true grinding stone on pedestal grinder	grinding stone on pedestal grinder is dressed and trued according to wear pattern

A-1.02.11P	inspect cutting dies and blades for ***damage***	cutting dies and blades are inspected for ***damage*** to ensure safe operation and quality product
A-1.02.12P	inspect forming dies	forming dies are inspected for damage and debris
A-1.02.13P	identify worn, damaged and defective parts in ***stationary machinery***, and remove them from service	worn, damaged and defective parts in ***stationary machinery*** are identified and removed from service

Range of Variables

stationary machinery includes: pedestal grinders, shears, drill presses, band saws, brakes, ironworkers, rollers

debris includes: steel shavings, off-cuts

filters include: fume extractors, moisture, oil, air

damage includes: chips, nicks, missing teeth

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.02.01L	demonstrate knowledge of ***stationary machinery***, their characteristics, applications and operation	identify types of ***stationary machinery***, and describe their characteristics and applications
		describe operating principles of ***stationary machinery***
		identify types of ***filters*** in ***stationary machinery***, and describe their characteristics and applications
		identify cutting fluids, and describe their characteristics and applications
		identify coolants, and describe their characteristics and applications
		identify ***lubricants***, and describe their characteristics and applications
A-1.02.02L	demonstrate knowledge of procedures to maintain and store ***stationary machinery***	identify tools and equipment used to maintain ***stationary machinery***, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to maintaining ***stationary machinery***
		describe procedures to LOTO ***stationary machinery***
		describe procedures to maintain ***stationary machinery***
		describe procedures to store ***stationary machinery***
		describe procedures to dispose of and recycle ***stationary machinery***

Range of Variables

stationary machinery includes: pedestal grinders, shears, drill presses, band saws, brakes, ironworkers, rollers

filters include: fume extractors, moisture, oil, air

lubricants include: grease, gear oil, cutting fluids

hazards include: electrical, hand injury, cuts, eye injury

A-1.03 Maintains thermal cutting equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.03.01P	LOTO thermal cutting equipment	thermal cutting equipment is locked and tagged out according to regulations and manufacturers' specifications
A-1.03.02P	clean or blow out power source for thermal cutting equipment	power source for thermal cutting equipment is cleaned or blown out
A-1.03.03P	identify and repair leaks	leaks are identified using ***methods*** and repaired
A-1.03.04P	repair or replace damaged gas and air lines to thermal cutting equipment	damaged gas and air lines to thermal cutting equipment are repaired or replaced
A-1.03.05P	perform diagnosis of thermal cutting equipment ***problems***	diagnosis of thermal cutting equipment ***problems*** is performed according to test cut
A-1.03.06P	clean and store thermal cutting equipment	thermal cutting equipment is cleaned and stored
A-1.03.07P	clean or replace ***consumables***	***consumables*** are cleaned or replaced
A-1.03.08P	identify worn, damaged and defective thermal cutting equipment, and take ***corrective action***	worn, damaged and defective thermal cutting equipment is identified, and ***corrective action*** is taken

Range of Variables

methods include: creep test, soap test

problems include: inconsistent operation, poor quality of cuts

consumables include: tips, diffusers, electrodes, nozzles, gas cylinders

corrective action includes: replacement, repair

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.03.01L	demonstrate knowledge of thermal cutting equipment, their ***components***, ***consumables***, characteristics, applications and operation	identify thermal cutting equipment and ***components***, and describe their characteristics and applications
		describe operating principles of thermal cutting equipment and their ***components***
		identify ***consumables*** used with thermal cutting equipment, and describe their characteristics and applications
A-1.03.02L	demonstrate knowledge of procedures to maintain and store thermal cutting equipment and ***components***	identify tools and equipment used to maintain thermal cutting equipment, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to maintaining thermal cutting equipment
		describe procedures to LOTO thermal cutting equipment
		describe procedures to maintain thermal cutting equipment
		describe procedures to store thermal cutting equipment
		describe procedures to dispose of and recycle thermal cutting equipment

Range of Variables

components include: power sources, regulators, hoses, torches
consumables include: tips, diffusers, electrodes, nozzles, gas cylinders
hazards include: electrical shocks, cuts, hand injury, burns

A-1.04 Maintains welding equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.04.01P	select and use tools and equipment	tools and equipment are selected and used according to task
A-1.04.02P	identify ***hazards*** and LOTO welding equipment	***hazards*** are identified and welding equipment is locked and tagged out
A-1.04.03P	clean or blow out power source for welding equipment	power source for welding equipment is cleaned or blown out

A-1.04.04P	identify and repair or replace damaged shielding gas lines and regulators	damaged shielding gas lines and regulators for welding equipment are identified and repaired or replaced
A-1.04.05P	perform diagnosis of welding equipment	diagnosis of welding equipment is performed to identify ***problems*** and ensure proper operation
A-1.04.06P	clean welding equipment	welding equipment is cleaned according to manufacturers' specifications
A-1.04.07P	perform basic service on gas-driven or diesel-driven welding equipment	basic service on gas-driven or diesel-driven welding equipment is performed using ***procedures*** according to manufacturers' specifications
A-1.04.08P	identify worn, damaged and defective welding equipment and take ***corrective action***	worn, damaged and defective welding equipment is identified and ***corrective action*** taken

Range of Variables

hazards include: electrical shocks, burns, particulate projection
problems include: inconsistent operation, poor weld quality
procedures include: checking fluid levels and filters
corrective action includes: replacement, repair or send out for calibration and service

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.04.01L	demonstrate knowledge of welding equipment, their characteristics, applications and operation	identify ***welding equipment***, and describe their characteristics and applications
		describe operating principles of ***welding equipment***
		interpret information pertaining to ***welding equipment*** found in manufacturers' specifications
A-1.04.02L	demonstrate knowledge of procedures to maintain and store ***welding equipment***	identify tools and equipment used to maintain ***welding equipment***, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to maintaining ***welding equipment***
		describe procedures to LOTO ***welding equipment***
		describe procedures to maintain ***welding equipment***
		describe procedures to store ***welding equipment***
		describe procedures to control waste and recycle ***welding equipment***

Range of Variables

welding equipment includes: cables, electrode holder, guns, power sources, wire feed, gas lines
hazards include: electrical shocks, burns, particulate projection

Task A-2 Uses access and material handling equipment

Task Descriptor

Welders use access and material handling equipment in order to safely and effectively perform the duties of their trade.

A-2.01 Uses access equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.01.01P	select ***access equipment***	***access equipment*** is selected according to job requirements
A-2.01.02P	inspect ***access equipment*** for operation and compliance	***access equipment*** is inspected according to manufacturers' specifications for operation and compliance
A-2.01.03P	identify unsafe, wo	unsafe, worn, damaged and defective ***access equipment*** is identified, and corrective action is taken
A-2.01.04P	verify scaffolding is secure, level and stable	scaffolding is secure, level and stable
A-2.01.05P	verify footing of ladders is secure, level and stable	footing of ladders is secure, level and stable
A-2.01.06P	operate ***access equipment***	***access equipment*** is operated according to manufacturers' specifications, and jurisdictional and OH&S regulations
A-2.01.07P	plan travel route of mobile access equipment	travel route of mobile access equipment is planned and operational range is accounted for
A-2.01.08P	cordon off work area	work area is cordoned off

A-2.01.09P	perform ***routine maintenance*** on ***access equipment***	***routine maintenance*** on ***access equipment*** is performed according to manufacturers' specifications
A-2.01.10P	secure and store ***access equipment*** in designated area	***access equipment*** is secured and stored in designated area according to company policies
A-2.01.11P	LOTO faulty ***access equipment***	faulty ***access equipment*** is locked and tagged out according to company policies

Range of Variables

access equipment includes: scaffolding, ladders, aerial work platforms, fall arrest harnesses, anchor points

routine maintenance includes: fluid top-ups, re-fuelling

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.01.01L	demonstrate knowledge of ***access equipment***, their characteristics, applications and operation	identify ***access equipment***, and describe their characteristics and applications
		describe operating principles of ***access equipment***
		identify safety shut-off buttons or switches, and describe their characteristics and applications
		explain load capacity limits and centre of gravity of access equipment
		describe considerations surrounding area and lift conditions and their effects on safe operation of ***access equipment***
A-2.01.02L	demonstrate knowledge of procedures to use and operate ***access equipment***	identify ***hazards***, and describe safe work practices pertaining to ***access equipment***
		identify ***ladder safety practices*** and describe their applications
		describe refuelling procedures
		describe procedures to use and operate ***access equipment***
		describe procedures to cordon off work area
		describe procedures to maintain ***access equipment***
		describe procedures to LOTO faulty ***access equipment***
		describe procedures to secure and store ***access equipment***

A-2.01.03L	demonstrate knowledge of training and certification requirements to use and operate ***access equipment***	identify training and certification requirements to use and operate ***access equipment***
A-2.01.04L	demonstrate knowledge of regulatory requirements pertaining to ***access equipment***	identify standards and jurisdictional regulations pertaining to ***access equipment***

Range of Variables

access equipment includes: scaffolding, ladders, aerial work platforms, fall arrest harnesses, anchor points

hazards include: falls, overhead, electrical, pinch/crush points

ladder safety practices include: 3-point contact, ladder slope, load capacity label, access and egress

A-2.02 Uses material handling equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.02.01P	select ***material handling equipment***	***material handling equipment*** is selected according to task
A-2.02.02P	inspect ***material handling equipment***	***material handling equipment*** is inspected and safe operation confirmed according to documented daily safety checks
A-2.02.03P	identify types of material	types of material are identified to determine weight
A-2.02.04P	calculate dimensions and weight	dimensions and weight are calculated according to material type, shape and size
A-2.02.05P	calculate sling angles	sling angles are calculated to ensure rigging is appropriate for load
A-2.02.06P	plan lift and path of travel, and confirm lay down area	lift and path of travel is planned to minimize lift time and hazards, and lay down area is confirmed
A-2.02.07P	adjust ***material handling equipment*** and secure load	***material handling equipment*** is adjusted and load secured
A-2.02.08P	cordon off work area	work area is cordoned off according to site and safety requirements
A-2.02.09P	transfer and monitor load	load is transferred and monitored during transfer using spotter as required
A-2.02.10P	perform and interpret hand signals	hand signals are performed and interpreted
A-2.02.11P	place and use tag lines	tag lines are placed and used

A-2.02.12P	use dunnage and softeners	dunnage and softeners are used to protect rigging and load
A-2.02.13P	place load in pre-selected area	load is placed in pre-selected area according to orientation required
A-2.02.14P	locate and interpret load charts when using forklifts	load charts are located and interpreted when using forklifts according to manufacturers' specifications
A-2.02.15P	store ***material handling equipment***	***material handling equipment*** is stored according to manufacturers' specifications and company policies

Range of Variables

material handling equipment includes: forklifts, rigging equipment, hoisting equipment, lifting equipment, dollies, chain falls, carts, conveyor rollers, shop cranes, overhead travelling cranes, mobile cranes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.02.01L	demonstrate knowledge of ***material handling equipment***, their ***components***, characteristics, applications and operation	identify ***material handling equipment*** and their ***components***, and describe their characteristics and applications
		describe operating principles of ***material handling equipment*** and their ***components***
		interpret information pertaining to ***material handling equipment*** found in manufacturers' specifications
		identify ***rigging devices***, and describe their characteristics and applications
		describe load weights, centre of gravity, shape and dimensions and its effect on safe operation of ***material handling equipment***
		describe surrounding area and lift conditions and their effect on safe operation of ***material handling equipment***
A-2.02.02L	demonstrate knowledge of procedures to use and operate ***material handling equipment***	identify ***hazards***, and describe safe work practices pertaining to ***material handling equipment***
		identify hand signals used to communicate during transferring and monitoring of load
		describe procedures to complete log books for overhead cranes and forklifts
		describe ***rigging methods***
		describe procedures to use and operate ***material handling equipment***

		describe procedures to store ***material handling equipment***
		describe procedures to dispose of ***material handling equipment***
A-2.02.03L	demonstrate knowledge of training and certification requirements to use and operate ***material handling equipment***	identify training and certification requirements to use and operate ***material handling equipment***
A-2.02.04L	demonstrate knowledge of regulatory requirements pertaining to ***material handling equipment***	identify standards and jurisdictional regulations pertaining to ***material handling equipment***

Range of Variables

material handling equipment includes: forklifts, rigging equipment, hoisting equipment, lifting equipment, dollies, chain falls, carts, conveyor rollers, shop cranes, overhead travelling cranes, mobile cranes

material handling components include: rigging devices, slings, ropes

rigging devices include: beam clamps, tag lines, spreader bars, load softeners, plate clamps

hazards include: falls, overhead, electrical, pinch/crush points, property and equipment damage

rigging methods include: using chokers and basket hitches, vertical hitch

Task A-3 Performs safety-related activities

Task Descriptor

Welders will encounter many hazards in their work environment. It is important that welders adhere to safety training, perform thorough hazard assessments, use personal protective equipment (PPE) and safety equipment correctly, and maintain a safe work environment.

A-3.01 Performs hazard assessments

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.01.01P	identify and report potential ***hazards***	potential ***hazards*** are identified by performing worksite inspection and reported according to company policies and OH&S requirements
A-3.01.02P	identify risks associated with changes in ***environmental conditions***	risks associated with changes in ***environmental conditions*** are identified

A-3.01.03P	identify risks associated with radiographic inspections	risks associated with radiographic inspections are identified
A-3.01.04P	participate in safety meetings	safety meetings with personnel are attended to understand and communicate ***hazards***

Range of Variables

hazards include: poor ventilation, chemical spills, toxic fumes, H_2S, electrical shocks, mechanical entanglement, potential explosions, radiological exposure

environmental conditions include: weather, time of day

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.01.01L	demonstrate knowledge of ***hazard*** assessments	identify elements of ***hazard*** assessments, and describe their applications
		describe risks associated with changes in ***environmental conditions***
		describe risks associated with radiographic inspections
A-3.01.02L	demonstrate knowledge of procedures to perform ***hazard*** assessments	identify tools and equipment used to perform ***hazard*** assessments, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to performing ***hazard*** assessments
		describe procedures to perform ***hazard*** assessments

Range of Variables

hazards include: poor ventilation, chemical spills, toxic fumes, H_2S, electrical shocks, mechanical entanglement, potential explosions, radiological exposure

environmental conditions include: weather, time of day

A-3.02 Maintains safe work environment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task
A-3.02.02P	participate in site orientation and safety training	site orientation and safety training is completed

A-3.02.03P	handle and store ***hazardous materials***	***hazardous materials*** are handled and stored in designated areas according to company policies, standards and Workplace Hazardous Materials Information System (WHMIS)
A-3.02.04P	install temporary ***safety protection***	temporary ***safety protection*** is installed according to site- or shop-specific requirements
A-3.02.05P	install individual locks on equipment lock-out devices	individual locks are installed on equipment lock-out devices to eliminate risk of energy entering workspace
A-3.02.06P	locate and clearly identify on-site ***safety locations***	on-site ***safety locations*** are located and clearly identified
A-3.02.07P	practice good housekeeping	good housekeeping is practiced
A-3.02.08P	plan safe route when moving material	safe route when moving material is planned
A-3.02.09P	follow ***emergency procedures***	***emergency procedures*** are followed according to company policies, risk assessment and site conditions
A-3.02.10P	ensure stationary machines' range of motion is unobstructed, guarded and well-marked	stationary machines' range of motion is unobstructed, guarded and well-marked
A-3.02.11P	ensure work site complies with requirements on safe ***work permits***	work site complies with requirements on safe ***work permits***
A-3.02.12P	protect or remove combustible materials	combustible materials are protected or removed from work area

Range of Variables

tools and equipment include: ventilation, monitors, spill kit

hazardous materials include: acids, compressed gases, fuels

safety protection includes: barriers, caution tape

safety locations include: first aid stations, eye wash stations, muster points, fire extinguishers

emergency procedures include: reporting hazardous spills, evacuation procedures, injured worker procedure/reporting, escape routes

work permits include: hot work permits, confined space entry permits

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.02.01L	demonstrate knowledge of safe work environments	identify ***safety locations***, and describe their characteristics and applications
		describe good housekeeping practices
		describe workers' rights and responsibilities
		identify required ventilation for cutting and welding processes, and describe their characteristics and applications
		identify emergency shut-down devices, and describe their characteristics and applications
A-3.02.02L	demonstrate knowledge of procedures to maintain safe work environment	identify ***tools and equipment*** used to maintain safe work environment, and describe their procedures for use
		describe procedures to maintain safe work environment
		identify ***hazardous materials***, and describe procedures to handle and store them
		describe procedures to install temporary ***safety protection***
		describe LOTO procedures
		describe ***emergency procedures***
		describe procedures to control waste and recycle ***materials***
A-3.02.03L	demonstrate knowledge of ***site-specific training*** and certification requirements to maintain safe work environment	identify ***site-specific training*** and certification requirements to maintain safe work environment
A-3.02.04L	demonstrate knowledge of regulatory requirements pertaining to maintaining safe work environments	identify standards and jurisdictional regulations pertaining to maintaining safe work environments

Range of Variables

safety locations include: first aid stations, eye wash stations, muster points, fire extinguishers

tools and equipment include: ventilation, monitors, spill kit

hazardous materials include: acids, compressed gases, fuels

safety protection includes: barriers, caution tape

emergency procedures include: reporting hazardous spills, evacuation procedures, injured worker procedure/reporting, escape routes

materials include: pickling compounds, oils, acids

site-specific training includes: equipment operation, working in confined spaces, use of fall protection systems, H_2S awareness

A-3.03 Uses personal protective equipment (PPE) and safety equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.03.01P	select ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are selected according to task, hazard, company policies and OH&S regulations
A-3.03.02P	inspect ***PPE*** and ***safety equipment*** for ***conditions*** and remove from service	***PPE*** and ***safety equipment*** are inspected for ***conditions*** and removed from service
A-3.03.03P	adjust ***PPE***	***PPE*** is adjusted to ensure proper fit according to manufacturers' specifications
A-3.03.04P	wear ***PPE*** and operate ***safety equipment***	***PPE*** is worn and ***safety equipment*** is operated according to manufacturers' specifications and safe working procedures
A-3.03.05P	store and maintain ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are stored and maintained according to manufacturers' specifications

Range of Variables

PPE includes: hard hats, respirators, hearing protection, fall arrest harnesses, face shields, safety footwear, safety glasses, filter lenses, welding helmet, welding gloves, flame-resistant clothing

safety equipment includes: fire extinguishers, safety blankets, grinder guards

conditions include: worn, damaged, expired, defective

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.03.01L	demonstrate knowledge of ***PPE*** and ***safety equipment***, their characteristics, applications and operation	identify ***PPE*** and ***safety equipment***, and describe their characteristics and applications
		describe operating principles of ***safety equipment***
		identify ***safety locations***, and describe their characteristics and applications
A-3.03.02L	demonstrate knowledge of procedures to use ***PPE*** and ***safety equipment***	describe procedures to select and use ***PPE*** and ***safety equipment***
		describe inspection practices to identify ***PPE*** and ***safety equipment conditions***
		describe procedures to store and maintain ***PPE*** and ***safety equipment***
		describe procedures to dispose of and recycle ***PPE*** and ***safety equipment***

A-3.03.03L	demonstrate knowledge of training and certification requirements to use ***PPE*** and ***safety equipment***	identify training and certification requirements to use ***PPE*** and ***safety equipment***
A-3.03.04L	demonstrate knowledge of regulatory requirements pertaining to using ***PPE*** and ***safety equipment***	identify standards and jurisdictional regulations pertaining to using ***PPE*** and ***safety equipment***

Range of Variables

PPE includes: hard hats, respirators, hearing protection, fall arrest harnesses, face shields, safety footwear, safety glasses, filter lenses, welding helmet, welding gloves, flame-resistant clothing

safety equipment includes: fire extinguishers, safety blankets, grinder guards

safety locations include: first aid stations, eye wash stations, muster points, fire extinguishers
conditions include: worn, damaged, expired, defective

Task A-4 Organizes work

Task Descriptor

In order to organize their work, welders must be able to use documents and reference materials, interpret drawings and welding symbols, plan their project tasks, and obtain and organize required materials.

A-4.01 Uses documentation and reference material

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-4.01.01P	access electronic ***work-related documents, reference documentation*** and ***manuals***	electronic ***work-related documents, reference documentation*** and ***manuals*** are accessed using digital devices and software
A-4.01.02P	complete ***work-related documents***	***work-related documents*** are completed according to company policies and procedures
A-4.01.03P	interpret ***reference documentation***	***reference documentation*** is interpreted
A-4.01.04P	locate information in ***manuals***	information in ***manuals*** is located
A-4.01.05P	convert between imperial and metric measurements	measurements between imperial and metric are converted

Range of Variables

work-related documents include: time sheets, machinery checklists, progress report sheets, weld maps, dimensional checks, visual weld inspections, incident reports

reference documentation includes: bill of materials, job plans, job specifications, Welding Procedures Specifications/Welding Procedures Data Sheets (WPS/WPDS), material traceability (mill reports), WHMIS materials

manuals include: codes, specifications, equipment manuals, quality manuals, health and safety manuals

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-4.01.01L	demonstrate knowledge of documentation and reference material, their characteristics and applications	identify types of ***work-related documents***, ***reference documentation*** and ***manuals***, and describe their characteristics and applications
		identify and interpret information found in ***reference documentation*** and ***manuals***
		describe procedures to complete ***work-related documents***
		describe procedures to convert between imperial and metric measurements
A-4.01.02L	demonstrate knowledge of procedures to use and complete documentation and reference material	describe procedures to use and complete documentation and reference material

Range of Variables

work-related documents include: time sheets, machinery checklists, progress report sheets, weld maps, dimensional checks, visual weld inspections, incident reports

reference documentation includes: bill of materials, job plans, job specifications, Welding Procedures Specifications/Welding Procedures Data Sheets (WPS/WPDS), material traceability (mill reports), WHMIS materials

manuals include: codes, specifications, equipment manuals, quality manuals, health and safety manuals

A-4.02 Interprets drawings and welding symbols

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-4.02.01P	access electronic ***drawings***	electronic ***drawings*** are accessed using digital devices and software
A-4.02.02P	review ***drawings*** and plans	***drawings*** and plans are reviewed to retrieve required information for task
A-4.02.03P	interpret and apply welding symbols and notes	welding symbols and notes are interpreted

A-4.02.04P	interpret ***types of lines***	***types of lines*** are interpreted
A-4.02.05P	convert between imperial and metric measurements	measurements between imperial and metric are converted
A-4.02.06P	extract ***information*** from ***drawings***	***information*** is extracted from ***drawings***
A-4.02.07P	identify necessary components and materials for fabrication	components and materials for fabrication are identified according to bill of materials on drawings

Range of Variables

drawings include: prints (blueprints), assembly drawings, detail drawings, shop and fabrication drawings, hand-drawn sketches, engineered drawings

types of lines include: broken, hidden, centre, section

information includes: dimensions, angles, non-destructive examination, tolerances, interferences, welding symbols

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-4.02.01L	demonstrate knowledge of ***drawings*** and welding symbols, their characteristics and applications	identify types of ***drawings*** and welding symbols, and describe their characteristics and applications
		interpret information and welding symbols found on ***drawings***
		identify ***types of lines***, and describe their characteristics and applications
		describe procedures to convert between imperial and metric measurements
		identify ***types of views*** on ***drawings***
		describe ***drafting principles***
A-4.02.02L	demonstrate knowledge of procedures to interpret ***drawings*** and welding symbols	describe procedures to interpret ***drawings*** and welding symbols

Range of Variables

drawings include: prints (blueprints), assembly drawings, detail drawings, shop and fabrication drawings, hand-drawn sketches, engineered drawings

types of lines include: broken, hidden, centre, section

types of views include: orthographic, isometric

drafting principles include: drawings, grids, scales, revisions

A-4.03 Plans job tasks

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-4.03.01P	determine ***task requirements***	***task requirements*** to complete job are determined
A-4.03.02P	sequence order of operations	order of operations is sequenced according to job specifications and task
A-4.03.03P	schedule jobs and tasks	jobs and tasks are scheduled according to availability of resources and access to site
A-4.03.04P	anticipate safety requirements	safety requirements are anticipated according to hazard assessment
A-4.03.05P	coordinate tasks with co-workers and other trades	tasks with co-workers and other trades are coordinated
A-4.03.06P	set up work area	work area is set up according to task
A-4.03.07P	generate cut lists and parts lists	cut lists and parts lists are generated according to drawings and bill of materials

Range of Variables

task requirements include: space, labour, materials, supplies, equipment

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-4.03.01L	demonstrate knowledge of ***task requirements***, their characteristics and applications	identify ***task requirements***, and describe their characteristics and applications
		identify considerations to estimate time required to complete project tasks
A-4.03.02L	demonstrate knowledge of procedures to plan job tasks	describe procedures to determine equipment, material and labour required to complete job
		describe procedures to sequence order of operations
		describe procedures to schedule jobs and tasks
		describe procedures to anticipate safety requirements

	describe procedures to coordinate tasks with co-workers and other trades
	describe procedures to set up work area
	describe procedures to generate cut lists and parts lists

Range of Variables

task requirements include: space, labour, materials, supplies, equipment

A-4.04 Organizes materials

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
A-4.04.01P	gather ***materials***	***materials*** are gathered according to cut list, parts list and job specifications
A-4.04.02P	verify bill of materials	bill of materials is verified by cross referencing with heat numbers, drawings and specifications
A-4.04.03P	document use of inventory	use of inventory is documented according to company policies
A-4.04.04P	complete order sheet for out-of-stock ***materials***	order sheet for out-of-stock ***materials*** is completed according to company policies and procedures
A-4.04.05P	queue and orientate ***materials***	***materials*** are queued and orientated according to sequence of assembly
A-4.04.06P	protect ***materials*** from damage	***materials*** are protected from damage using ***coverings***

Range of Variables

materials include: beams, plates, bar stock, pipe, tubing, flanges, elbows
coverings include: sheathing, blankets, cardboard

Knowledge

	Learning Outcomes	Learning Objectives
A-4.04.01L	demonstrate knowledge of procedures to organize ***materials***	describe procedures to gather ***materials***
		describe procedures to verify bill of materials and their origin
		describe procedures to document use of inventory

	describe procedures to complete order sheet for out-of-stock ***materials***
	describe procedures to queue and orientate ***materials***
	identify ***coverings*** used to protect ***materials*** from damage

Range of Variables

materials include: beams, plates, bar stock, pipe, tubing, flanges, elbows

coverings include: sheathing, blankets, cardboard

Task A-5 Performs routine trade activities

Task Descriptor

Welders perform various activities during the cutting, gouging and welding processes. With the wealth of available equipment, welders must be able to select appropriate welding processes and power sources. They must follow manufacturers' specifications, company policies and safety regulations in start-up and shut-down of equipment.

Welders use methods of marking and identification for traceability. They apply heat and regulate cooling to control chemical and mechanical properties of the material. They properly store consumables to ensure weld quality.

Quality assurance is important in this trade in order to produce quality products, save time and money, and ensure the required specifications are met. Welders use various methods of inspection to ensure quality. After the welding process, welders finish the final product to customer and code requirements.

A-5.01 Performs quality inspection

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-5.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task
A-5.01.02P	identify ***material defects***	***material defects*** are identified by performing visual inspection
A-5.01.03P	confirm dimensions and weld specifications	dimensions and weld specifications are confirmed by performing visual inspection and referring to drawings
A-5.01.04P	identify ***fabrication defects***	***fabrication defects*** are identified by performing visual inspection

A-5.01.05P	continually check for dimensional distortion during welding process and recommend corrective measures	dimensional distortion during welding is identified and corrective measures are applied
A-5.01.06P	select and use ***measuring devices***	***measuring devices*** are selected and used to verify weld dimensions according to job specifications and codes
A-5.01.07P	identify ***weld discontinuities*** and defects	***weld discontinuities*** and defects are identified by performing visual inspection
A-5.01.08P	identify ***surface imperfections***	***surface imperfections*** are identified by performing visual inspection
A-5.01.09P	determine acceptability of identified ***fabrication*** and ***material defects***, and ***weld discontinuities*** and defects	acceptability of identified ***fabrication*** and ***material defects***, and ***weld discontinuities*** and defects is determined according to job specifications and codes
A-5.01.10P	maintain records and reports of material defects and ***weld discontinuities***	records and reports of material defects and ***weld discontinuities*** are maintained

Range of Variables

tools and equipment include: flashlights, magnifying lenses, measuring devices, inspection mirrors

material defects include: surface irregularities, laminations, surface contamination

fabrication defects include: improper fit-up, misalignment, distortion, incorrect dimensions and orientation

measuring devices include: gauges (fillet weld, depth, high-lo, bridge cam), steel rulers

weld discontinuities include: porosity, undercut, cold lap, excess or incomplete penetration

surface imperfections include: welding spatter, gouges, stray arc strikes, sharp edges

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.01.01L	demonstrate knowledge of quality inspections, their characteristics and applications	identify visual acceptance criteria
		identify ***material defects***, and describe mitigation or repair methods
		identify ***fabrication defects***, and describe mitigation or repair methods
		identify ***weld discontinuities*** and defects, and describe mitigation or repair methods
		identify ***surface imperfections***, and describe mitigation or repair methods
		interpret information pertaining to quality inspection criteria found on drawings, job specifications and codes

A-5.01.02L	demonstrate knowledge of procedures to perform quality inspections	identify ***tools and equipment*** used to perform quality inspections, and describe their procedures for use
		identify hazards, and describe safe work practices pertaining to performing quality inspections
		describe procedures to perform quality inspections
		describe ***non-destructive testing methods***, their characteristics and applications
		describe ***destructive testing methods***, their characteristics and applications
		identify ***measurements*** to be verified
		describe an inspection test plan (ITP) and explain its purpose

Range of Variables

material defects include: surface irregularities, laminations, surface contamination

fabrication defects include: improper fit-up, misalignment, distortion, incorrect dimensions and orientation

weld discontinuities include: porosity, undercut, cold lap, excess or incomplete penetration

surface imperfections include: welding spatter, gouges, stray arc strikes, sharp edges

tools and equipment include: flashlights, magnifying lenses, measuring devices, inspection mirrors

non-destructive testing methods include: radiography, ultrasonic, liquid penetrant, magnetic particle examination, hydro, phased array

destructive testing methods include: bend and tensile strength, etching, impact, hardness

measurements include: material, weld, on-going dimensional, final product

A-5.02 Marks welds, materials and parts

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-5.02.01P	determine type and size of material, and part numbers	type and size of material and part numbers are determined by referencing drawings and job specifications
A-5.02.02P	transfer ***identification markings*** from stock material to cut parts	***identification markings*** are transferred from stock material to cut parts for traceability
A-5.02.03P	mark welder identification symbol on finished welds	welder identification symbol is marked on finished welds according to job specifications

Range of Variables

identification markings include: heat numbers, grain direction, lot and job numbers, material grade

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.02.01L	demonstrate knowledge of marking welds, materials and parts	identify welds, ***types of materials*** and parts that are marked
		identify ***identification markings***, and describe their characteristics and applications
		identify mill test reports (MTR), and describe their characteristics and applications
		identify methods companies use to organize materials
		describe ***reasons for marking material and parts***
		describe ***personalized welder identification***

A-5.02.02L	demonstrate knowledge of procedures to mark welds, materials and parts	identify marking devices used to mark welds, materials and parts, and describe their procedures for use
		identify hazards, and describe safe work practices pertaining to marking welds, materials and parts
		describe procedures to mark welds, materials and parts
A-5.02.03L	demonstrate knowledge of regulatory requirements pertaining to marking welds, materials and parts	identify codes, standards and regulations pertaining to marking welds, materials and parts

Range of Variables

types of materials include: ferrous and non-ferrous
identification markings include: heat numbers, grain direction, lot and job numbers, material grade
reasons for marking material and parts include: traceability, identification for fabrication and erection
personalized welder identifications include: initials, numbers

A-5.03 Controls temperature of weldments

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
A-5.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task
A-5.03.02P	determine ***heating requirements***	***heating requirements*** are determined according to WPS/WPDS and job specifications
A-5.03.03P	select and use ***temperature measuring devices***	***temperature measuring devices*** are selected and used to monitor temperature
A-5.03.04P	apply heat	heat is applied using ***tools and equipment*** and methods according to WPS/WPDS and job specifications
A-5.03.05P	follow procedures for different alloys	procedures for different alloys are followed according to WPS/WPDS and job specifications

A-5.03.06P	maintain pre-heat, interpass and post-weld temperature	pre-heat, interpass and post-weld temperature are maintained according to WPS/WPDS to prevent weld defects and maintain mechanical properties
A-5.03.07P	control cooling rate	cooling rate is controlled using ***methods*** according to WPS/WPDS and job specifications

Range of Variables

tools and equipment include: insulation, heating tip (rose bud), heavy duty propane torch (tiger torch), induction heating coils, ovens

heating requirements include: pre-heat, control of interpass temperature, post-heat applications

temperature measuring devices include: temperature sticks, thermocouples, pyrometers

methods include: insulation, heating coils, ovens

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.03.01L	demonstrate knowledge of effects of temperature on weldments	describe ***heating requirements***, their characteristics and applications
		identify ***hardness scales***, and describe their characteristics and applications
		describe metallurgy of materials
A-5.03.02L	demonstrate knowledge of procedures to control temperature of weldments	identify ***tools and equipment*** used to control temperature of weldments, and describe their procedures for use
		identify ***temperature measuring devices***, and describe their characteristics, applications and procedures for use
		identify ***hazards***, and describe safe work practices pertaining to controlling temperature of weldments
		describe procedures and ***methods*** to control temperature of weldments
		describe procedures to apply heat, and ***heat effects*** on material
		describe ***heat treatment methods***, their characteristics and applications

		describe ***cooling processes***
		describe procedures to control waste and recycle insulation
A-5.03.03L	demonstrate knowledge of WPS/WPDS pertaining to controlling temperature of weldments	identify and interpret WPS/WPDS pertaining to controlling temperature of weldments

Range of Variables

heating requirements include: pre-heat, control of interpass temperature, post-heat applications

hardness scales include: Rockwell, Brinell, Vickers

tools and equipment include: insulation, heating tip (rose bud), heavy duty propane torch (tiger torch), induction heating coils, ovens

temperature measuring devices include: temperature sticks, thermocouples, pyrometers

hazards include: burns, electrical shocks

methods include: insulation, heating coils, ovens

heat effects include: expansion, contraction, distortion, mechanical properties

heat treatment methods include: annealing, tempering, normalizing, hardening

cooling processes include: quenching, controlled cooling

A-5.04 Stores welding consumables and gas cylinders

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-5.04.01P	identify ***welding consumables***	***welding consumables*** are identified according to product labels and manufacturers' specifications
A-5.04.02P	identify ***gas cylinders***	***gas cylinders*** are identified according to product labels and manufacturers' specifications
A-5.04.03P	identify storage requirements for ***welding consumables***	storage requirements for ***welding consumables*** are identified according to manufacturers' specifications, codes and jurisdictional regulations
A-5.04.04P	identify ***storage requirements for gas cylinders***	***storage requirements for gas cylinders*** are identified according to manufacturers' specifications, codes and jurisdictional regulations
A-5.04.05P	place ***welding consumables*** in environmentally controlled area	***welding consumables*** are placed in environmentally controlled area according to safety data sheet (SDS), manufacturers' specifications, company procedures and codes

A-5.04.06P	place ***gas cylinders*** in designated area	***gas cylinders*** are placed in designated area according to company procedures, codes and jurisdictional regulations
A-5.04.07P	select and use ***equipment*** to keep ***welding consumables*** at desired temperature	***equipment*** is selected and used to keep ***welding consumables*** at desired temperature according to manufacturers' specifications and codes
A-5.04.08P	identify and remove ***damaged products*** from service	***damaged products*** are identified and removed from service
A-5.04.09P	identify and remove damaged ***gas cylinders*** from service	damaged ***gas cylinders*** are identified and removed from service according to company procedures

Range of Variables

welding consumables include: electrodes, welding wires, welding fluxes

gas cylinders include: fuel, oxygen, inert, active

storage requirements for gas cylinders include: oxygen kept separate from fuels, ventilation, kept in vertical position, secured with chains

equipment includes: portable, stationary electrode and flux ovens

damaged products include: damaged electrodes, torn bags of flux, unidentified welding consumables

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.04.01L	demonstrate knowledge of ***welding consumables***, their characteristics and applications	identify ***welding consumables***, and describe their characteristics and applications
		interpret information pertaining to ***welding consumables*** found on WPS/WPDS and job specifications
		identify environmentally controlled areas, and describe their characteristics and applications
A-5.04.02L	demonstrate knowledge of procedures to store ***welding consumables***	identify ***equipment*** used to store ***welding consumables***, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to storing ***welding consumables***
		describe procedures and storage requirements for ***welding consumables***
		describe procedures to control waste and recycle ***damaged products***
A-5.04.03L	demonstrate knowledge of ***gas cylinders***, their characteristics and applications	identify ***gas cylinders***, and describe their characteristics and applications
		interpret information pertaining to ***gas cylinders*** found in standards, jurisdictional regulations and safe work practices

A-5.04.04L	demonstrate knowledge of procedures to store ***gas cylinders***	identify ***hazards***, and describe safe work practices pertaining to storing ***gas cylinders***
		describe procedures and ***storage requirements for gas cylinders***
		describe procedures to identify and remove damaged ***gas cylinders*** from service
A-5.04.05L	demonstrate knowledge of regulatory requirements pertaining to storage of ***gas cylinders***	identify standards and jurisdictional regulations pertaining to storage of ***gas cylinders***

Range of Variables

welding consumables include: electrodes, welding wires, welding fluxes
equipment includes: portable, stationary electrode and flux ovens
hazards (welding consumables) include: burns, lifting, flux dust
damaged products include: damaged electrodes, torn bags of flux, unidentified welding consumables
gas cylinders include: fuel, oxygen, inert, active
hazards (gas cylinders) include: explosions, displacement of oxygen (asphyxiation)
storage requirements for gas cylinders include: oxygen kept separate from fuels, ventilation, kept in vertical position, secured with chains

A-5.05 Selects welding processes and power source

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-5.05.01P	determine limitations and advantages of different ***welding processes***	limitations and advantages of different ***welding processes*** are determined according to job requirements and environmental conditions
A-5.05.02P	select ***welding process***	***welding process*** is selected according to WPS/WPDS, job requirements, and type, grade and thickness of material

A-5.05.03P	select power source	power source is selected according to ***welding process***, and voltage and amperage requirements
A-5.05.04P	select stationary or portable power source	stationary or portable power source is selected according to location of project and power availability

Range of Variables

welding processes include: shielded metal arc welding (SMAW), flux cored arc welding (FCAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW), metal cored arc welding (MCAW), submerged arc welding (SAW)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.05.01L	demonstrate knowledge of ***welding processes*** and power sources, their characteristics and applications	identify ***welding processes***, and describe their characteristics and applications
		identify power sources, and describe their characteristics and applications
		interpret information pertaining to ***welding processes*** and power sources found in WPS/WPDS, drawings, and manufacturers' and job specifications
		identify stationary or portable power sources, and describe their limitations and advantages

A-5.05.02L	demonstrate knowledge of procedures to select ***welding processes*** and power sources	describe procedures and factors to consider when selecting ***welding processes*** and power sources
A-5.05.03L	demonstrate knowledge of emerging technologies related to ***welding processes*** and power sources	identify emerging technologies related to ***welding processes*** and power sources, and describe their characteristics and applications

Range of Variables

welding processes include: shielded metal arc welding (SMAW), flux cored arc welding (FCAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW), metal cored arc welding (MCAW), submerged arc welding (SAW)

A-5.06 Performs equipment start-up and shut-down

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-5.06.01P	verify electrical, gas and air supplies are connected properly	inspection of equipment verifies electrical, gas and air supplies are connected properly
A-5.06.02P	identify damaged equipment and remove from service	damaged equipment is identified and removed from service
A-5.06.03P	start up and shut down equipment	equipment is started up and shut down according to manufacturers' specifications, company policies and safety regulations

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.06.01L	demonstrate knowledge of equipment start-up and shut-down	identify equipment start-up and shut-down requirements
		identify ***hazards***, and describe safe work practices pertaining to start-up and shut-down of equipment
		describe procedures to start up and shut down equipment

Range of Variables

hazards include: electrical shocks, burns, exhaust fumes

A-5.07 Finishes final product

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-5.07.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task
A-5.07.02P	identify finishes	finishes are identified according to drawings and job specifications
A-5.07.03P	identify weld profile	weld profile is identified according to drawings and job specifications
A-5.07.04P	identify ***weld discontinuities*** and defects, and ***surface imperfections***	***weld discontinuities*** and defects, and ***surface imperfections*** are identified by performing visual inspection
A-5.07.05P	repair and finish ***weld discontinuities*** and defects, and ***surface imperfections***	***weld discontinuities*** and defects, and ***surface imperfections*** are repaired using industry approved repair procedures
A-5.07.06P	prepare weldments and other pieces	weldments and other pieces are prepared according to WPS/WPDS, job specifications and codes
A-5.07.07P	chemically clean weldments	weldments are chemically cleaned to remove ***undesirable materials***
A-5.07.08P	prepare weldments for galvanizing	weldments are prepared for galvanizing by providing air bleeds and drain holes
A-5.07.09P	label parts for traceability	labels are attached to parts to ensure traceability
A-5.07.10P	sort assemblies for ***specific finishes***	assemblies are sorted for ***specific finishes***

Range of Variables

tools and equipment include: grinders, wire wheels, buffers

weld discontinuities include: porosity, undercut, cold lap, excess or incomplete penetration

surface imperfections include: welding spatter, gouges, stray arc strikes, sharp edges, plate clamp gouges, miscellaneous defects

undesirable materials include: oils, oxides

specific finishes include: coatings, pickling, machining, blasting

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-5.07.01L	demonstrate knowledge of finishes	identify types of finishes, and describe their characteristics and applications
		interpret information pertaining to finishes found on drawings and job specifications
A-5.07.02L	demonstrate knowledge of procedures to finish final product	identify ***tools and equipment*** used to finish final product, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to finishing final products
		identify ***weld discontinuities*** and defects, and ***surface imperfections***, and describe their characteristics and procedures to repair them
		identify ***undesirable materials*** and procedures to remove them
		describe procedures to finish final products

Range of Variables

tools and equipment include: grinders, wire wheels, buffers

hazards include: particulate projection/sparks, cuts, dust/particulate inhalation, toxic chemicals

weld discontinuities include: porosity, undercut, cold lap, excess or incomplete penetration

surface imperfections include: welding spatter, gouges, stray arc strikes, sharp edges, plate clamp gouges, miscellaneous defects

undesirable materials include: oils, oxides

Task A-6 Uses communication and mentoring techniques

Task Descriptor

Learning in the trades is done primarily in the workplace with tradespeople passing on their skills and knowledge to apprentices, as well as sharing knowledge among themselves. Apprenticeship is, and always has been about mentoring – learning workplace skills and passing them on. Because of the importance of this to the trade, this task covers the activities related to communication in the workplace and mentoring skills.

A-6.01 Uses communication techniques

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-6.01.01P	demonstrate communication practices with individuals or in a group	instructions and messages are interpreted by all parties involved in communication
A-6.01.02P	listen using ***active listening*** practices	***active listening*** practices are utilized
A-6.01.03P	speak clearly using correct industry terminology to ensure understanding	understanding of message is confirmed by both parties
A-6.01.04P	receive and respond to instructions	response to instructions indicates understanding
A-6.01.05P	receive and respond to feedback on work completed or performed	response to feedback indicates understanding and corrective measures are taken
A-6.01.06P	explain and provide feedback	explanation and feedback is provided and task is carried out as directed
A-6.01.07P	use questions to improve communication	questions enhance understanding, on-the-job training and goal setting
A-6.01.08P	participate in safety and information meetings	meetings are attended, information is relayed to workforce, and is applied
A-6.01.09P	send and receive ***electronic messages***	***electronic messages*** are sent and received using professionalism, plain language and clear expressions according to company policies

Range of Variables

active listening includes: hearing, interpreting, reflecting, responding, paraphrasing
electronic messages include: emails, text messages

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-6.01.01L	demonstrate knowledge of trade terminology	define terminology used in trade
A-6.01.02L	demonstrate knowledge of effective communication practices	describe importance of using effective verbal and non-verbal communication with ***people in the workplace***
		identify ***sources of information*** to effectively communicate
		identify communication and ***learning styles***
		describe effective listening and speaking skills
		describe how to receive and give instructions effectively
		identify ***personal responsibilities and attitudes*** that contribute to on-the-job success
		identify value of equity, diversity and inclusion in workplace
		identify communication that constitutes bullying, ***harassment*** and ***discrimination***
		identify communication styles appropriate to different systems and applications of ***electronic messages***

Range of Variables

people in the workplace include: other tradespeople, colleagues, apprentices, supervisors, clients, jurisdictional representatives, manufacturers

sources of information include: regulations, codes, occupational health and safety requirements, jurisdictional requirements, drawings, specifications, company and client documentation

learning styles include: visual, auditory, reading, writing, kinesthetic

personal responsibilities and attitudes include: asking questions, working safely, accepting constructive feedback, time management and punctuality, respect for authority, good stewardship of materials, tools and property, efficient work practice

harassment: as defined by the Canadian and jurisdictional Human Rights Commissions

discrimination: as defined by the Canadian Human Rights Act and jurisdictional human rights laws

electronic messages include: emails, text messages

A-6.02 Uses mentoring techniques

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-6.02.01P	identify and communicate learning objective and point of lesson	apprentice or learner can explain objective and point of lesson
A-6.02.02P	link lesson to other lessons and project	lesson order and unplanned learning opportunities are defined
A-6.02.03P	demonstrate performance of a skill to an apprentice or learner	***steps required to demonstrate a skill*** are performed
A-6.02.04P	set up conditions required for apprentice or learner to practice a skill	***practice conditions*** are set up so that skill can be practiced safely by apprentice or learner
A-6.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice or learner improves with practice to a point where skill can be done with little supervision
A-6.02.06P	give supportive and corrective feedback	apprentice or learner adopts best practice after having been given supportive or corrective feedback
A-6.02.07P	support apprentices or learners in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority
A-6.02.08P	support anti-***harassment*** and anti-***discrimination*** practices in workplace	workplace is ***harassment*** and ***discrimination***-free
A-6.02.09P	assess apprentice or learner suitability to trade during probationary period	apprentice or learner is given constructive feedback that helps them identify their own strengths and weaknesses and suitability for the trade

Range of Variables

steps required to demonstrate a skill include: understanding who, what, where, when, why, and how; explaining; showing; giving encouragement; following up to ensure skill is performed correctly

practice conditions means: guided, limited independence, full independence

harassment: as defined by the Canadian and jurisdictional Human Rights Commissions

discrimination: as defined by the Canadian Human Rights Act and jurisdictional human rights laws

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-6.02.01L	demonstrate knowledge of strategies for learning skills in workplace	describe importance of individual experience
		describe shared responsibilities for workplace learning

		determine one's own learning preferences and explain how these relate to learning new skills
		describe importance of different types of skills in workplace
		describe importance of ***skills for success*** (***essential skills)*** in workplace
		identify different ***learning styles***
		identify different ***learning needs*** and strategies to meet them
		identify ***strategies to assist in learning a skill***
A-6.02.02L	demonstrate knowledge of strategies for teaching workplace skills	identify different roles played by workplace mentor
		describe ***teaching skills***
		explain importance of identifying point of lesson
		identify how to select a good time to present lesson
		explain importance of linking lessons
		identify context for learning skills
		describe considerations in setting up opportunities for skill practice
		explain importance of providing feedback
		identify techniques for giving effective feedback
		describe a skills assessment
		identify methods of assessing progress
		explain how to adjust lesson to different situations

Range of Variables

skills for success (essential skills) are: adaptability, collaboration, communication, creativity and innovation, digital, numeracy, problem solving, reading, writing

learning styles include: visual, auditory, reading, writing, kinesthetic

learning needs include: learning disabilities, learning preferences, language proficiency

strategies to assist in learning a skill include: understanding the basic principles of instruction, developing coaching skills, being mature and patient, providing feedback

teaching skills include: identifying point of lesson, linking lesson, demonstrating skill, providing practice, giving feedback, assessing skills and progress

Major Work Activity B
Performs layout and fabrication of components for welding

Task B-7 Performs layout

Task Descriptor

Welders lay out materials before any fabrication procedure such as cutting, drilling, bending and welding. It is important that the layout be done properly to prevent waste and ensure proper fit and accuracy.

B-7.01 Develops templates

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-7.01.01P	select and use ***measuring and layout tools and equipment***	***measuring and layout tools and equipment*** are selected and used according to task
B-7.01.02P	determine template materials and ***properties***	template materials and ***properties*** are determined according to specific application
B-7.01.03P	determine starting point	starting point is determined according to working point and axis
B-7.01.04P	extend or create lines from working points	lines are extended or created from working points
B-7.01.05P	transfer dimensions from drawing to template	dimensions are transferred from drawing to template
B-7.01.06P	complete profile	profile is completed from transferred dimensions
B-7.01.07P	shape template	template is shaped using ***measuring and layout tools and equipment*** according to ***template materials***
B-7.01.08P	mark template with ***information***	template is marked with ***information***

Range of Variables

measuring and layout tools and equipment include: combination squares, measuring tapes, plumb bobs, marking devices, compasses, trammel points, straightedges, string lines, dividers, levels, transfer punches, center punches, radius markers

properties include: durability, fire resistance

template materials include: wood, cardboard, metal, paper

information includes: part numbers, layout information, material required

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-7.01.01L	demonstrate knowledge of templates, their characteristics and applications	identify ***types of templates***, and describe their characteristics and applications
		describe principles of templates
		interpret information pertaining to templates found on drawings and specifications
		identify template materials, and describe their ***properties*** and applications
		identify imperial and metric systems of measurements and describe conversion factors
		identify reference points and dimensions that need to be transferred
		identify starting point, working points and axis, and describe their characteristics and applications
		identify ***information*** marked on templates, and describe their characteristics and applications
B-7.01.02L	demonstrate knowledge of procedures to develop templates	identify ***measuring and layout tools and equipment*** used to develop templates, and describe their procedures for use
		identify ***digital measuring tools*** used to develop templates and describe their characteristics, applications and procedures for use
		identify ***hazards***, and describe safe work practices pertaining to developing templates
		describe procedures to develop template
		describe procedures to identify starting point, working points and axis
		describe procedures to transfer dimensions from drawing to template
		describe procedures to complete profile

		describe procedures to cut template
		describe procedures to dispose of and recycle templates
		describe ***template materials***
B-7.01.03L	demonstrate knowledge of emerging technologies related to developing templates	identify emerging technologies related to developing templates, and describe their characteristics and applications

Range of Variables

types of templates include: hole-punching templates, wrap arounds, cutting templates, arc templates (sweeps)

properties include: durability, fire resistance

information includes: part numbers, layout information, material required

measuring and layout tools and equipment include: combination squares, measuring tapes, plumb bobs, marking devices, compasses, trammel points, straightedges, string lines, dividers, levels, transfer punches, center punches, radius markers

digital measuring tools include: calipers, levels, measuring devices

hazards include: pinch points, burns, debris

template materials include: wood, cardboard, metal, paper

B-7.02 Transfers dimensions from drawings to materials

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-7.02.01P	select and use ***measuring and layout tools and equipment***	***measuring and layout tools and equipment*** are selected and used according to task
B-7.02.02P	interpret information from drawings and welding symbols	information is interpreted from drawings and welding symbols and is transferred to materials
B-7.02.03P	determine ***work points***	***work points*** are determined to identify location and orientation of components according to drawings
B-7.02.04P	perform ***mathematical calculations***	***mathematical calculations*** are performed according to task
B-7.02.05P	determine total material required	total material required is determined according to ***factors*** to maximize efficiency and quality
B-7.02.06P	verify layout for accuracy	layout is verified for accuracy according to drawings, specifications, and company policies and procedures

Range of Variables

measuring and layout tools and equipment include: combination squares, measuring tapes, plumb bobs, marking devices, compasses, trammel points, straightedges, string lines, dividers, levels, transfer punches, center punches

work points include: centre lines, hole locations, end preparation lines, base point, axis

mathematical calculations include: conversions, ratios, proportions, fractions, geometry, decimals

factors include: size, material usage, seam location, bend allowances, kerf, job requirements

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-7.02.01L	demonstrate knowledge of transferring dimensions from drawings to ***template material***	identify ***template materials***, and describe their characteristics and applications
		interpret information and symbols pertaining to dimensions found on drawings and specifications
		identify work points and axis, and describe their characteristics and applications
B-7.02.02L	demonstrate knowledge of procedures to transfer dimensions from drawings to materials	identify ***measuring and layout tools and equipment*** used to transfer dimensions from drawings to materials, and describe their procedures for use
		identify ***digital measuring tools*** used to transfer dimensions from drawings to materials and describe their characteristics, applications and procedures for use
		identify ***hazards***, and describe safe work practices pertaining to transferring dimensions from drawings to materials
		describe procedures to transfer dimensions from drawings to materials
		describe procedures to determine ***work points***
		perform ***mathematical calculations*** used to transfer dimensions from drawings to materials
		describe procedures to verify layout

Range of Variables

template materials include: wood, cardboard, metal

measuring and layout tools and equipment include: combination squares, measuring tapes, plumb bobs, marking devices, compasses, trammel points, straightedges, string lines, dividers, levels, transfer punches, center punches

digital measuring tools include: calipers, levels, measuring devices

hazards include: pinch points, burns, debris, cuts

work points include: centre lines, hole locations, end preparation lines, base point, axis

mathematical calculations include: conversions, ratios, proportions, fractions, geometry, decimals

Task B-8 Fabricates components

Task Descriptor

Fabrication is the process done prior to welding. It involves preparation of materials and fitting and assembling them. These processes are often done in conjunction with other tradespersons. It is critical that pieces be fabricated within the tolerances of specifications.

B-8.01 Prepares materials

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task
B-8.01.02P	verify components' dimensions, conditions and grade	components' material type, grade, thickness and size are verified to ensure compliance with job specifications
B-8.01.03P	verify all ***preparation processes*** have been completed	all ***preparation processes*** have been completed according to drawings and specifications
B-8.01.04P	clean weld areas	weld areas are cleaned using ***abrasive techniques*** according to WPS/WPDS, job specifications and material requirements
B-8.01.05P	prepare edge for assembly	edge is prepared for assembly by squaring or bevelling according to job specifications, tolerances and information in welding symbols

Range of Variables

preparation processes include: drilling, punching, forming, grinding, thermal processes

abrasive techniques include: grinding, using a file, chemicals

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.01.01L	demonstrate knowledge of welding components and materials, their characteristics and applications	identify welding components and materials, and describe their characteristics and applications
		interpret information pertaining to welding components and materials found on drawings and specifications
		describe ***preparation process***
		describe cleaning process using ***abrasive techniques***
		describe characteristics and applications of dimensional tolerances
		describe imperial and metric systems of measurements and conversions
B-8.01.02L	demonstrate knowledge of procedures to prepare welding components and materials	identify tools and equipment used to prepare welding components and materials, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to preparing welding components and materials
		describe procedures to perform material ***preparation processes***
		describe procedures to clean weld areas
		describe procedures to prepare edge for assembly
		describe procedures to dispose of and recycle welding components and materials

Range of Variables

preparation processes include: drilling, punching, forming, grinding, thermal processes
abrasive techniques include: grinding, using a file, chemicals
hazards include: pinch points, burns, debris

B-8.02 Fits components for welding

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.02.01P	select and use ***tools and equipment*** for tacking	***tools and equipment*** for tacking are selected and used according to task
B-8.02.02P	join components mechanically	components are joined mechanically according to drawings and specifications using clamps and fixtures
B-8.02.03P	pre-heat base metals for tacking	base metals are pre-heated for tacking according to job specifications
B-8.02.04P	select tacking materials and ***tacking methods***	tacking materials and ***tacking methods*** are selected according to job specifications
B-8.02.05P	join components by tacking	components are joined by tacking according to job specifications
B-8.02.06P	identify and repair common ***discontinuities*** in a tack	***discontinuities*** in tack are identified and repaired according to industry approved repair procedures
B-8.02.07P	identify and repair common ***defects*** in a tack	***defects*** in tack are identified and repaired according to industry approved repair procedures
B-8.02.08P	identify ***methods to control expansion and contraction***	***methods to control expansion and contraction*** are identified

Range of Variables

tools and equipment include: hi-lo gauges, wedges, clamps, sawhorses, jigs, fixtures

tacking methods include: bridge, penetrating, plug

discontinuities include: porosity, slag inclusions

defects include: lack of penetration, incomplete penetration, lack of fusion, incomplete fusion, undercut, spatter, slag inclusions, cracks, porosity, overlap

methods to control expansion and contraction include: using strongbacks, gussets and tacking sequence, heat sinks

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.02.01L	demonstrate knowledge of components for welding, their characteristics, applications	identify components for welding, and describe their characteristics and applications
		interpret information pertaining to components for welding found on drawings and specifications
		identify types of base metals, and describe their characteristics and applications
		identify types and sizes of tacks, and describe their characteristics and applications
		describe pre-heating requirements for tacking
		describe sequence of tacks
		describe welding processes to be used after tacking
		describe impact of tack welding on base metals
		describe inspection requirements for components
B-8.02.02L	demonstrate knowledge of procedures to fit components for welding	identify ***tools and equipment*** used to fit components for welding, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to fitting components for welding
		describe procedures to join components for welding
		describe ***tacking methods***
		describe ***methods to control expansion and contraction***
		describe procedures to repair common ***defects*** in a tack
		describe procedures to dispose of and recycle components for welding
B-8.02.03L	demonstrate knowledge of regulatory requirements pertaining to tacking components	identify codes, standards and regulations pertaining to tacking components

Range of Variables

tools and equipment include: hi-lo gauges, wedges, clamps, sawhorses, jigs, fixtures

hazards include: pinch points, burns, debris, rotating equipment

tacking methods include: bridge, penetrating, plug

methods to control expansion and contraction include: using strongbacks, gussets and tacking sequence, heat sinks

defects include: lack of penetration, incomplete penetration, lack of fusion, incomplete fusion, undercut, spatter, slag inclusions, cracks, porosity, overlap

B-8.03 Assembles components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to task
B-8.03.02P	determine sequence for assembly	sequence for assembly is determined according to drawings
B-8.03.03P	set gaps and alignments	gaps and alignments are set within tolerance levels according to specifications
B-8.03.04P	fit, place and adjust components	components are fit, placed and adjusted, ensuring they are level, plumb and orientated according to drawings
B-8.03.05P	fasten components	components are fastened together using ***fastening devices*** according to plans and specifications
B-8.03.06P	verify assembly throughout all stages	assembly is verified throughout all stages according to drawings and specifications

Range of Variables

tools and equipment include: hi-lo gauges, wedges, clamps, sawhorses, jigs and fixtures, cranes, slings, alignment tools

fastening devices include: bolts, clips

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.03.01L	demonstrate knowledge of components, their characteristics, applications and operation	identify components, and describe their characteristics and applications
		identify ***fastening devices***, and describe their characteristics and applications
		interpret information pertaining to components found on drawings and specifications
		identify ***assembly constraints***
		identify isometric and orthographic views and sketching techniques for assembly plan
		identify material allowances for bending, braking and rolling
B-8.03.02L	demonstrate knowledge of procedures to assemble components	identify ***tools and equipment*** used to assemble components, and describe their procedures for use
		identify ***hazards***, and describe safe work practices pertaining to assembling components
		describe procedures to assemble components
B-8.03.03L	demonstrate knowledge of regulatory requirements pertaining to assembling components for pressure vessels	identify codes, standards and regulations pertaining to assembling components for pressure vessels

Range of Variables

fastening devices include: bolts, clips

assembly constraints include: building size, equipment limitations

tools and equipment include: hi-lo gauges, wedges, clamps, sawhorses, jigs and fixtures, cranes, slings, alignment tools

hazards include: pinch points, burns, debris

Major Work Activity C
Performs cutting and gouging

Task C-9 Uses tools and equipment for non-thermal cutting and grinding

Task Descriptor

Welders must match tools and equipment with the material being cut and ground. They must be aware of tool applications and limitations. They must select the proper blade or disc for the task.

C-9.01 Selects cutting and grinding tools

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-9.01.01P	identify ***type of material*** being cut or ground	***type of material*** being cut or ground is identified according to job specifications
C-9.01.02P	select ***cutting and grinding tools and equipment***	***cutting and grinding tools and equipment*** are selected according to application, grade and thickness of material, type of cut and tool limitation
C-9.01.03P	select cutting and grinding ***consumables***	cutting and grinding ***consumables*** are selected according to material type, grade, thickness, size and finish required, and manufacturers' specifications

Range of Variables

types of material include: stainless steel, aluminum, carbon steel, high alloy

cutting and grinding tools and equipment include: band saw, cold cut saws, nibblers, power hacksaws, ironworkers, shears, hand tools, power tools

consumables include: discs, blades, wire wheels

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.01.01L	demonstrate knowledge of materials, their characteristics and applications	identify ***types of materials***, and describe their characteristics and applications
C-9.01.02L	demonstrate knowledge of ***cutting and grinding tools and equipment***, their characteristics, applications and limitations	identify ***cutting and grinding tools and equipment***, and describe their characteristics, applications and limitations
		identify air pressure ratings of pneumatic grinders, and describe their characteristics and applications
		identify types of blades for cutting ferrous metals and non-ferrous metals, and describe their characteristics and applications
		identify ***types of discs***, and describe their characteristics, applications and limitations
		identify ***consumables***, and describe their characteristics and applications
C-9.01.03L	demonstrate knowledge of procedures to use ***cutting and grinding tools and equipment***	identify ***hazards***, and describe safe work practices pertaining to ***cutting and grinding tools and equipment*** used to cut materials
		describe procedures to use ***cutting and grinding tools and equipment***
		describe procedures to control waste and recycle cut materials

Range of Variables

types of material include: stainless steel, aluminum, carbon steel, high alloy

cutting and grinding tools and equipment include: band saw, cold cut saws, nibblers, power hacksaws, ironworkers, shears, hand tools, power tools

types of discs include: composite, carbide, abrasive

consumables include: discs, blades, wire wheels

hazards include: cuts, flying debris, noise, fire

C-9.02 Cuts using stationary power tools

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
C-9.02.01P	select feed and speed rates	feed and speed rates are selected according to material type, grade, thickness, size and manufacturers' specifications
C-9.02.02P	measure material to be cut	material to be cut is measured according to drawings and specifications
C-9.02.03P	secure material	material is secured according to manufacturers' specifications to prevent damage to blade and material, and injury
C-9.02.04P	perform cut	cut is performed according to job specifications
C-9.02.05P	verify cut parameters and cut quality	cut parameters and cut quality are verified for accuracy

Knowledge

	Learning Outcomes	Learning Objectives
C-9.02.01L	demonstrate knowledge of materials, their characteristics and applications	identify ***types of materials***, and describe their characteristics and applications
C-9.02.02L	demonstrate knowledge of ***stationary power tools***, their characteristics, applications and limitations	identify ***stationary power tools***, and describe their characteristics, applications and procedures for use
		identify types of blades for cutting ferrous metals and non-ferrous metals, and describe their characteristics and applications
		identify blade clearances, speed, direction, composition and pitch
		identify ***types of cuts***, and describe their characteristics and applications
C-9.02.03L	demonstrate knowledge of procedures to cut materials using ***stationary power tools***	identify ***hazards***, and describe safe work practices pertaining to cutting materials using ***stationary power tools***
		describe procedures to cut materials using ***stationary power tools***
		describe procedures to control waste and recycle cut materials

Range of Variables

types of material include: stainless steel, aluminum, carbon steel, high alloy
stationary power tools include: band saws, cold cut saws, power hacksaws, pedestal grinder, drill press
types of cuts include: straight, bevel, compound
hazards include: cuts, noise, rotating equipment

C-9.03 Cuts using shears and ironworkers

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
C-9.03.01P	select shear and ironworker settings	shear and ironworker settings are selected according to material type, grade, thickness, size and manufacturers' specifications to avoid blade and equipment damage
C-9.03.02P	measure material to be cut	material to be cut is measured according to drawings and specifications
C-9.03.03P	secure material	material is secured according to manufacturers' specifications to prevent damage to blade and material, and injury
C-9.03.04P	perform cut	cut is performed according to job specifications
C-9.03.05P	verify cut parameters and cut quality	cut parameters and cut quality are verified for accuracy

Knowledge

	Learning Outcomes	Learning Objectives
C-9.03.01L	demonstrate knowledge of materials, their characteristics and applications	identify ***types of materials***, and describe their characteristics and applications
C-9.03.02L	demonstrate knowledge of shears and ironworkers, their characteristics, ***applications*** and ***limitations***	identify shears and ironworkers, and describe their characteristics, ***applications*** and ***limitations***
		identify digital shears, and describe their characteristics, applications and procedures for use

C-9.03.03L	demonstrate knowledge of procedures to cut materials using shears and ironworkers	identify ***hazards***, and describe safe work practices pertaining to cutting materials using shears and ironworkers
		describe procedures to cut materials using shears and ironworkers
		describe procedures to control waste and recycle cut materials

Range of Variables

types of material include: stainless steel, aluminum, carbon steel
applications include: cutting plates, structural shapes, punching holes
limitations include: type, grade, thickness and size of material being cut
hazards include: pinching, cuts, shattered tooling

C-9.04 Cuts using hand tools

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
C-9.04.01P	measure material to be cut	material to be cut is measured according to drawings and specifications
C-9.04.02P	secure material	material is secured using ***manufactured safety devices*** to prevent damage to hand tools and material, and injury
C-9.04.03P	perform cut	cut is performed according to job specifications
C-9.04.04P	verify cut parameters and cut quality	cut parameters and cut quality are verified for accuracy

Range of Variables

manufactured safety devices include: locking pliers, clamps, chain grips

Knowledge

	Learning Outcomes	Learning Objectives
C-9.04.01L	demonstrate knowledge of materials, their characteristics and applications	identify ***types of materials***, and describe their characteristics and applications
C-9.04.02L	demonstrate knowledge of ***hand tools***, their characteristics, applications and limitations	identify ***hand tools***, and describe their characteristics, applications and limitations
		describe ***types of cuts***, and identify their applications

C-9.04.03L	demonstrate knowledge of procedures to cut materials using ***hand tools***	identify ***hazards***, and describe safe work practices pertaining to cutting materials using ***hand tools***
		describe procedures to cut materials using ***hand tools***
		describe procedures to control waste and recycle cut materials

Range of Variables

types of material include: stainless steel, aluminum, carbon steel, high alloy
hand tools include: hacksaws, files, snips, pipe cutters, chisels
types of cuts include: straight, radius
hazards include: flying debris, cuts, scrapes

C-9.05 Cuts using portable power tools

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-9.05.01P	select speed	speed is selected according to material type, grade, thickness, size and manufacturers' specifications to avoid tool damage and injury
C-9.05.02P	measure material to be cut	material to be cut is measured according to drawings and specifications
C-9.05.03P	secure material	material is secured according to manufacturers' specifications to prevent damage to tools and material, and injury
C-9.05.04P	perform cutting or grinding operation	cutting or grinding operation is performed according to job specifications
C-9.05.05P	verify cut parameters and cut quality	cut parameters and cut quality are verified for accuracy

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.05.01L	demonstrate knowledge of materials, their characteristics and applications	identify ***types of materials***, and describe their characteristics and applications
C-9.05.02L	demonstrate knowledge of ***portable power tools***, their characteristics, applications and limitations	identify ***portable power tools***, and describe their characteristics, applications and limitations
		identify types of coolants, and describe their characteristics and applications
		identify feed rates, clearances, speed, direction, composition and pitch
		describe ***types of cuts*** and their applications
		identify ***types of discs***, and describe their characteristics and applications
		identify ***types of blades***, and describe their characteristics and applications
C-9.05.03L	demonstrate knowledge of procedures to cut materials using ***portable power tools***	identify ***hazards***, and describe safe work practices pertaining to cutting materials using ***portable power tools***
		describe procedures to cut materials using ***portable power tools***
		describe procedures to control waste and recycle cut materials

Range of Variables

types of material include: ferrous and non-ferrous (stainless steel, aluminum, carbon steel, high alloy)

portable power tools include: circular and reciprocating saws, angle and die grinders, beveling machines, nibblers

types of cuts include: straight, bevel, radius

types of discs include: composite, carbide, abrasive

types of blades include: bi-metal, carbon steel, carbide, diamond

hazards include: flying debris, sparks, rotating equipment, fire, electrical shocks

Task C-10 Uses oxy-fuel gas cutting (OFC) process for cutting and gouging

Task Descriptor

This task covers the selection and proper use of oxy-fuel equipment for cutting and gouging. Welders must be able to select the equipment to use according to the thickness of materials being cut. They must also be able to recognize hazards associated with this process.

This cutting process is cost-effective and versatile, requires no external power source and results in quality cuts. The equipment is portable and is used primarily for cutting carbon steel.

C-10.01 Selects oxy-fuel cutting (OFC) gas and equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-10.01.01P	select ***oxy-fuel cutting (OFC) equipment***	***OFC equipment*** is selected according to task
C-10.01.02P	select ***type of regulator***	***type of regulator*** is selected according to application and gas type
C-10.01.03P	select type of torch and size of hoses	type of torch and size of hoses are selected according to application
C-10.01.04P	select type and size of tip	type and size of tip are selected according to material thickness, application and gas type
C-10.01.05P	select ***type of oxy-fuel gases***	***type of oxy-fuel gases*** is selected according to availability and job task
C-10.01.06P	identify and select oxygen and fuel cylinders/manifolds	oxygen and fuel cylinders/manifolds are identified according to suppliers' labels and selected according to volumetric requirement
C-10.01.07P	select manual or mechanized torch ***cutting systems***	manual or mechanized torch ***cutting systems*** are selected according to application

Range of Variables

OFC equipment includes: torches, hoses, flashback arrestors, regulators, torch bodies, tips, mechanized oxy-fuel cutting equipment (bevellers, track cutters), fuel cylinders/manifolds, high-pressure cylinders, reverse-flow check valve

types of regulators include: single- and two-stage, low- and high-pressure

types of oxy-fuel gases include: acetylene, natural gas, propane, methylacetylene-propadiene (MPS), oxygen

cutting systems include: track cutters (motorized carriage), pipe beveling cutters, automated cutting table

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe metallurgy of base metals
		identify base metals that can and cannot be cut using ***OFC equipment***
C-10.01.02L	demonstrate knowledge of OFC gases and ***equipment***, their characteristics, applications and operation	identify OFC gases and ***equipment***, and describe their characteristics and applications
		describe operating principles of OFC gases and ***equipment***
		interpret and apply welding symbols and information pertaining to OFC processes found on drawings and specifications
		identify ***types of regulators***, and describe their characteristics and applications
		identify ***types of oxy-fuel gases***, and describe their ***characteristics*** and applications
		identify oxygen and fuel cylinders/manifolds by suppliers' labels, and describe their safety features, characteristics and applications
		describe limitations of oxy-fuel cutting and gouging
		identify manual or mechanized torch ***cutting systems***
C-10.01.03L	demonstrate knowledge of regulatory requirements pertaining to OFC gases and ***equipment***	identify codes, standards and regulations pertaining to OFC gases and ***equipment***
C-10.01.04L	demonstrate knowledge of emerging technologies related to OFC gases	identify emerging technologies related to OFC gases, and describe their characteristics and applications

Range of Variables

OFC equipment includes: torches, hoses, flashback arrestors, regulators, torch bodies, tips, mechanized oxy-fuel cutting equipment (bevellers, track cutters), fuel cylinders/manifolds, high-pressure cylinders, reverse-flow check valve

types of regulators include: single- and two-stage, low- and high-pressure

types of oxy-fuel gases include: acetylene, natural gas, propane, methylacetylene-propadiene (MPS), oxygen

characteristics (of oxy-fuel gas) include: oxygen to fuel gas ratio, maximum flame temperature, heat distribution of primary and secondary flame

cutting systems include: track cutters (motorized carriage), pipe beveling cutters, automated cutting table

C-10.02 Sets up oxy-fuel cutting (OFC) equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-10.02.01P	move and secure oxygen and fuel cylinders	oxygen and fuel cylinders are moved and secured to prevent damage to cylinder and property, and injury
C-10.02.02P	open cylinder valves and check for debris	cylinder valves are opened and debris is removed according to manufacturers' specifications
C-10.02.03P	install ***OFC equipment*** (components and safety devices)	***OFC equipment*** (components and safety devices) are installed according to manufacturers' specifications and jurisdictional regulations

Range of Variables

OFC equipment includes: torches, hoses, flashback arrestors, regulators, torch bodies, tips, automated oxy-fuel cutting equipment (bevellers, track cutters), fuel cylinders/manifolds, high-pressure cylinders, reverse-flow check valves

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.02.01L	demonstrate knowledge of ***OFC equipment***, their characteristics, applications and operation	identify ***OFC equipment***, and describe their characteristics and applications
		describe operating principles of ***OFC equipment***
		interpret and apply welding symbols and information pertaining to OFC process found on drawings and specifications
		identify ***types of regulators***, and describe their characteristics and applications
		identify ***types of oxy-fuel gases***, and describe their ***characteristics*** and applications
		identify oxygen and fuel cylinders/manifolds by suppliers' labels, and describe their safety features, characteristics and applications
		identify manual or mechanized torch ***cutting systems***

C-10.02.02L	demonstrate knowledge of procedures to set up ***OFC equipment***	identify ***hazards***, and describe safe work practices pertaining to setup of ***OFC equipment***
		describe procedures to set up ***OFC equipment***
		distinguish between characteristics and applications of left- and right-hand threads for fuel gas and oxygen
		describe procedures to secure oxygen and fuel cylinders in safe locations
		identify locations and causes of flashbacks, backfires and leaks, and methods for prevention and solution
		describe manufacturers' specifications related to assembly and setup of ***OFC equipment***
C-10.02.03L	demonstrate knowledge of regulatory requirements pertaining to OFC gases and ***equipment***	identify standards and regulations pertaining to OFC gases and ***equipment***
C-10.02.04L	demonstrate knowledge of emerging technologies related to OFC gases	identify emerging technologies related to OFC gases, and describe their characteristics and applications

Range of Variables

OFC equipment includes: torches, hoses, flashback arrestors, regulators, torch bodies, tips, automated oxy-fuel cutting equipment (bevellers, track cutters), fuel cylinders/manifolds, high-pressure cylinders, reverse-flow check valves

type of regulators include: single- and two-stage, low- and high-pressure

types of oxy-fuel gases include: acetylene, natural gas, propane, MPS, oxygen

characteristics (of oxy-fuel gas) include: thermal volume, temperature output

cutting systems include: track cutters (motorized carriage), pipe beveling cutters, automated cutting table

hazards include: burns, sparks, eye hazards, fumes, high pressure cylinders, regulator blow-outs, critical explosion level, maximum safe working pressures

C-10.03 Sets operating parameters for oxy fuel cutting (OFC) equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
C-10.03.01P	adjust working pressures on regulators	working pressures on regulators are adjusted according to manufacturers' recommendations
C-10.03.02P	light torch and adjust oxygen	torch is lit and oxygen is adjusted to fuel ratio to obtain correct ***type of flame*** according to application
C-10.03.03P	verify operating parameters, and tip selection and operating condition	operating parameters, and tip selection and operating condition are verified by performing trial cut and using manufacturers' specifications and recommendations

Range of Variables

type of flame includes: neutral, carburizing, oxidizing

Knowledge

	Learning Outcomes	Learning Objectives
C-10.03.01L	demonstrate knowledge of ***OFC equipment***, their characteristics, applications and operation	identify ***OFC equipment***, and describe their characteristics and applications
		describe operating principles of ***OFC equipment***
		interpret and apply welding symbols and information pertaining to OFC process found on drawings and specifications
		identify ***types of flames***, and describe their characteristics and applications
C-10.03.02L	demonstrate knowledge of procedures to set operating parameters for ***OFC equipment***	identify ***hazards***, and describe safe work practices pertaining to set operating parameters for ***OFC equipment***
		describe procedures to set operating parameters for ***OFC equipment***
		describe oxy-fuel pressure requirements for cutting

C-10.03.03L	demonstrate knowledge of regulatory requirements pertaining to OFC gases and ***equipment***	identify standards and regulations pertaining to OFC gases and ***equipment***
C-10.03.04L	demonstrate knowledge of emerging technologies related to OFC gases	identify emerging technologies related to OFC gases, and describe their characteristics and applications

Range of Variables

OFC equipment includes: torches, hoses, flashback arrestors, regulators, torch bodies, tips, automated oxy-fuel cutting equipment (bevellers, track cutters), fuel cylinders/manifolds, high-pressure cylinders, reverse-flow check valves

type of flame includes: neutral, carburizing, oxidizing

hazards include: burns, sparks, eye hazards, fumes, high pressure cylinders, regulator blow-outs, critical explosion level, maximum safe working pressures

C-10.04 Performs cut and gouge using OFC equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-10.04.01P	start up equipment	equipment is started up according to safe operating procedures and manufacturers' recommendations
C-10.04.02P	ignite fuel gas and adjust torch valves	fuel gas is ignited and torch valves are adjusted according to ***type of flame*** for task
C-10.04.03P	pre-heat material to kindling point	material is pre-heated to kindling point to initiate cut
C-10.04.04P	perform cut	cut is performed according to task without defects or minimal deformations
C-10.04.05P	identify and correct defects	defects are identified and corrected to ensure quality of cut
C-10.04.06P	adjust and maintain travel speed and torch angle	travel speed and torch angle are adjusted and maintained according to ***factors*** to achieve a consistent cut or gouge
C-10.04.07P	identify and correct backfire and flashback conditions	backfire and flashback conditions are identified and corrected
C-10.04.08P	shut down equipment	equipment is shut down and purged according to safe operating procedures and manufacturers' recommendations

Range of Variables

type of flame includes: neutral, carburizing, oxidizing

factors include: base metal, thickness of base metal, heat input

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal metallurgy
		identify base metals that can and cannot be cut using ***OFC equipment***
C-10.04.02L	demonstrate knowledge of procedures to cut and gouge using ***OFC equipment***	identify ***hazards***, and describe safe work practices pertaining to cutting and gouging using ***OFC equipment***
		identify ***OFC equipment*** used to cut and gouge, and describe their procedures for use
		interpret and apply welding symbols and information pertaining to OFC process found on drawings and specifications
		identify types and sizes of cutting and gouging tips, and describe their characteristics and applications
		identify ***types of flames***, and describe their characteristics and applications
		describe procedures to cut and gouge material using ***OFC equipment***
		describe procedures to identify and correct defects
		describe procedures to adjust and maintain travel speed and torch angle
		describe procedures to correct backfire and flashback conditions
		describe procedures to start up and shut down ***OFC equipment***
C-10.04.03L	demonstrate knowledge of regulatory requirements pertaining to OFC gases and ***equipment***	identify standards and regulations pertaining to OFC gases and ***equipment***
C-10.04.04L	demonstrate knowledge of emerging technologies related to OFC gases	identify emerging technologies related to OFC gases, and describe their characteristics and applications

Range of Variables

OFC equipment includes: torches, hoses, flashback arrestors, regulators, torch bodies, tips, automated oxy-fuel cutting equipment (bevellers, track cutters), fuel cylinders/manifolds, high-pressure cylinders, reverse-flow check valves

hazards include: burns, sparks, eye hazards, fumes, high pressure cylinders, regulator blow-outs, critical explosion level, maximum safe working pressures, confined space (release of explosive gas, asphyxiation)

type of flame includes: neutral, carburizing, oxidizing

Task C-11 Uses plasma arc cutting (PAC) process for cutting and gouging

Task Descriptor

Welders use the PAC process to cut ferrous and non-ferrous material; it provides clean cuts with minimal distortion and a small heat-affected zone in the material. Typically, this process requires minimal clean-up following the cutting operation.

C-11.01 Selects PAC equipment and consumables

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-11.01.01P	select ***PAC equipment*** and ***components***	***PAC equipment*** and ***components*** are selected according to application, amperage range, thickness and type of material
C-11.01.02P	select PAC ***consumables***	PAC ***consumables*** are selected according to cutting or gouging requirements
C-11.01.03P	select air or gas	air or gas is selected according to type of material, application and quality of cut or gouge

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-11.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal metallurgy

C-11.01.02L	demonstrate knowledge of ***PAC equipment*** and ***components***, their ***consumables***, characteristics, applications and operation	identify ***PAC equipment*** and ***components***, and describe their characteristics and applications
		interpret and apply welding symbols and information pertaining to PAC process found on drawings and specifications
		describe operating principles of ***PAC equipment***
		interpret information pertaining to gouging using ***PAC systems*** found in drawings and specifications
		identify PAC ***consumables***, and describe their characteristics and applications
		describe fundamentals of PAC process
		identify power sources, and describe their characteristics and applications
		describe compressed air and gas supply characteristics and applications
		identify air dryers and filters required on compressed air supply
		identify coolant level for liquid-cooled equipment
		describe travel speed

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

C-11.02 Sets up PAC equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-11.02.01P	visually inspect ***PAC equipment*** and ***components*** for damage	***PAC equipment*** and ***components*** are visually inspected for damage
C-11.02.02P	assemble PAC ***consumables*** on torch head	PAC ***consumables*** are assembled on torch head according to manufacturers' specifications or recommendations
C-11.02.03P	connect torch to power source	torch is connected to power source

C-11.02.04P	set up regulator	regulator is set up according to manufacturers' specifications
C-11.02.05P	attach work lead clamp to base metal	work lead clamp is attached to base metal to ensure proper electrical connection
C-11.02.06P	adjust power supply	power supply is adjusted according to base metal application

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-11.02.01L	demonstrate knowledge of ***PAC equipment*** and ***components***, their ***consumables***, characteristics, applications and operation	identify ***PAC equipment***, ***components*** and ***consumables***, and describe their characteristics and applications
		describe operating principles of ***PAC equipment***
		interpret and apply welding symbols and information pertaining to PAC process found on drawings and specifications
		identify regulators, and describe their characteristics and applications
		identify power sources, and describe their characteristics and applications
C-11.02.02L	demonstrate knowledge of procedures to set up ***PAC equipment***, ***components*** and ***consumables***	identify ***hazards***, and describe safe work practices pertaining to setting up ***PAC equipment***
		describe procedures to set up ***PAC equipment***, ***components*** and ***consumables***
		describe procedures to control waste and recycle ***components*** and ***consumables***
C-11.02.03L	demonstrate knowledge of training and certification requirements for ***PAC equipment***	identify training and certification requirements for ***PAC equipment***
		identify training and certification requirements and limitations pertaining to setting up primary wiring for ***PAC equipment***

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

hazards include: fumes, burns, sparks, electrical shocks, noise, radiation

C-11.03 Sets operating parameters for PAC equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-11.03.01P	set amperage	amperage is set according to base metal grade and thickness
C-11.03.02P	set air pressure	air pressure is set according to manufacturers' specifications
C-11.03.03P	set travel speed	travel speed is set on semi-automatic and automatic ***PAC equipment*** according to material type and thickness
C-11.03.04P	verify for cut defects	cut defects are verified by performing trial cut and using manufacturers' specifications and recommendations

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-11.03.01L	demonstrate knowledge of ***PAC equipment*** and ***components***, their ***consumables***, characteristics, applications and operation	identify ***PAC equipment, components*** and ***consumables***, and describe their characteristics and applications
		describe operating principles of ***PAC equipment***
		interpret and apply welding symbols and information pertaining to PAC process found on drawings and specifications
		identify amperages, and describe their characteristics and applications
		identify amount of air pressure required, and describe its effects on cut or gouge

		identify travel speed required, and describe its effects on cut or gouge
C-11.03.02L	demonstrate knowledge of procedures to set operating parameters for ***PAC equipment***	identify ***hazards***, and describe safe work practices pertaining to setting operating parameters for ***PAC equipment***
		describe procedures to set operating parameters for ***PAC equipment***
		describe procedures to control waste and recycle ***components*** and ***consumables***
		identify safe working pressures

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

hazards include: fumes, burns, sparks, electrical shocks, noise, radiation

C-11.04 Performs cut and gouge using PAC equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-11.04.01P	start up equipment	equipment is started up according to safe operating procedures and manufacturers' recommendations
C-11.04.02P	apply ***PAC techniques***	***PAC techniques*** are applied
C-11.04.03P	identify and correct defects	defects are identified and corrected to ensure quality of cut or gouge
C-11.04.04P	replace damaged or worn ***PAC equipment***, ***components*** and ***consumables***	damaged or worn ***PAC equipment***, ***components*** and ***consumables*** are replaced
C-11.04.05P	adjust and maintain travel speed	travel speed is adjusted and maintained taking into consideration ***factors*** to achieve consistent cut or gouge
C-11.04.06P	identify equipment ***malfunctions***	equipment ***malfunctions*** are identified and corrected
C-11.04.07P	use jigs and guides during cutting operations	jigs and guides are used during cutting operations
C-11.04.08P	shut down equipment	equipment is shut down according to safe operating procedures and manufacturers' recommendations

Range of Variables

PAC techniques include: initiating the arc and cut, starting at the correct stand-off distance

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

factors include: type and thickness of base metal, heat input

malfunctions include: low gas pressure, inadequate or poor work lead connection

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-11.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal metallurgy
C-11.04.02L	demonstrate knowledge of procedures to cut using ***PAC equipment***	identify ***hazards***, and describe safe work practices pertaining to cutting and gouging using ***PAC equipment***
		interpret and apply welding symbols and information pertaining to PAC process found on drawings and specifications
C-11.04.03L	demonstrate knowledge of procedures to set up ***PAC equipment***, ***components*** and ***consumables***	identify ***PAC equipment***, ***components*** and ***consumables*** used to cut and gouge, and describe procedures for use
		describe procedures and ***techniques*** to cut and gouge material using ***PAC equipment***
		describe procedures to identify and correct defects
		describe procedures to adjust and maintain travel speed and torch angl
		identify ***cutting aids***, jigs and guides used during cutting operations, and describe their characteristics and applications
		describe procedures to start up and shut down ***PAC equipment***
		describe procedures to control waste and recycle PAC ***components*** and ***consumables***

Range of Variables

PAC equipment includes: power source, track and pipe beveling cutters, manual, semi-automatic, automatic, shields, compressor

hazards include: fumes, burns, sparks, electrical shocks, noise, radiation

components include: heat shield, torch bodies, hoses, work lead clamp

consumables include: electrodes, constricting nozzles (tips)

PAC techniques include: initiating the arc and cut, starting at the correct stand-off distance

cutting aids include: stand-off, circle cutting attachments, drag nozzle

Task C-12 Uses air carbon arc cutting (CAC-A) process for cutting and gouging

Task Descriptor

The CAC-A process is used for bevel preparation and removing welds. It can also be used for back gouging. This process is a fast and efficient method of gouging metals. It is also used for removing cracks, repair and demolition.

C-12.01 Selects CAC-A equipment and consumables

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-12.01.01P	select ***CAC-A equipment*** and ***components***	***CAC-A equipment*** and ***components*** are selected according to application, amperage range, thickness and type of material
C-12.01.02P	select power source	power source is selected according to application
C-12.01.03P	select gouging torches and work lead clamps	gouging torches and work lead clamps are selected according to amperage and size of electrode
C-12.01.04P	select ***type of carbon electrode***	***type of carbon electrode*** is selected according to application and base metal
C-12.01.05P	select size of carbon electrodes	size of carbon electrodes is selected according to amount of material to be removed
C-12.01.06P	select air supply	air supply with sufficient volume and pressure is selected according to application

Range of Variables

CAC-A equipment includes: power source, compressor

components include: hoses, electrode holder, cables, work lead clamp

types of carbon electrodes include: coated, non-coated, flat, round, half-round, alternating current (AC), direct current (DC)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-12.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal metallurgy
		identify base metals that can and cannot be cut or gouged using ***CAC-A equipment***
C-12.01.02L	demonstrate knowledge of ***CAC-A equipment*** and ***components***, and ***types of carbon electrodes***, their characteristics, applications and operation	identify ***CAC-A equipment*** and ***components***, and describe their characteristics and applications
		describe operating principles of ***CAC-A equipment***
		identify ***types of carbon electrodes***, and describe their characteristics and applications
		interpret and apply welding symbols and information pertaining to CAC-A process found on drawings and specifications
		identify power sources, and describe their characteristics and applications
		identify types of torches and work lead clamps, and describe their characteristics and applications
		identify amount of air pressure required, and describe its effects on cuts or gouges

Range of Variables

CAC-A equipment includes: power source, compressor

components include: hoses, electrode holder, cables, work lead clamp

types of carbon electrodes include: coated, non-coated, flat, round, half-round, alternating current (AC), direct current (DC)

C-12.02 Sets up CAC-A equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-12.02.01P	visually inspect equipment and ***components*** for damage	equipment and ***components*** are visually inspected for damage
C-12.02.02P	attach CAC-A ***components*** to power source	CAC-A ***components*** are attached to power source according to manufacturers' recommendations, current type and application
C-12.02.03P	attach CAC-A ***components*** to air supply	CAC-A ***components*** are attached to air supply
C-12.02.04P	attach work lead clamp to base metal	work lead clamp is attached to base metal to ensure proper electrical connection

Range of Variables

components include: hoses, electrode holder, cables, work lead clamp

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-12.02.01L	demonstrate knowledge of ***CAC-A equipment*** and ***components***, their characteristics, applications and operation	identify ***CAC-A equipment*** and ***components***, and describe their characteristics and applications
		interpret and apply welding symbols and information pertaining to CAC-A process found on drawings and specifications
		identify power sources, and describe their characteristics and applications
		identify amount of air pressure required, and describe its effects on cuts or gouges
C-12.02.02L	demonstrate knowledge of procedures to set up ***CAC-A equipment***	identify ***hazards***, and describe safe work practices pertaining to setup of ***CAC-A equipment***
		describe procedures to set up ***CAC-A equipment*** and ***components***
		describe procedures to control waste

Range of Variables

CAC-A equipment includes: power source, compressor

components include: hoses, electrode holder, cables, work lead clamp

hazards include: fumes, burns, sparks, electrical shocks, noise, radiation, molten material

C-12.03 Sets operating parameters for CAC-A equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-12.03.01P	set amperage	amperage is set according to size, shape, type of carbon electrodes and manufacturers' specifications
C-12.03.02P	adjust regulator	regulator is adjusted to provide sufficient air pressure to CAC-A ***components***
C-12.03.03P	verify operating parameters and electrode selection	operating parameters and electrode selection are verified by performing trial cut or gouge and using manufacturers' specifications and recommendations

Range of Variables

components include: hoses, electrode holder, cables, work lead clamp

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-12.03.01L	demonstrate knowledge of ***CAC-A equipment***, ***components*** and electrodes, their characteristics, applications and operation	identify ***CAC-A equipment***, ***components*** and electrodes, and describe their characteristics and applications
		describe operating principles of ***CAC-A equipment***
		interpret and apply welding symbols and information pertaining to CAC-A process found on drawings and specifications
		identify ***electrical characteristics*** of ***CAC-A equipment*** and electrodes, and describe their applications
C-12.03.02L	demonstrate knowledge of procedures to set operating parameters for ***CAC-A equipment***	identify ***hazards***, and describe safe work practices pertaining to setting operating parameters for ***CAC-A equipment***
		describe procedures to set operating parameters for ***CAC-A equipment***

Range of Variables

CAC-A equipment includes: power source, compressor
components include: hoses, electrode holder, cables, work lead clamp
electrical characteristics include: current type, duty cycle
hazards include: fumes, burns, sparks, electrical shocks, noise, radiation, molten material

C-12.04 Performs cut and gouge using CAC-A equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
C-12.04.01P	start up ***CAC-A equipment***	***CAC-A equipment*** is started up according to safe operating procedures and manufacturers' recommendations
C-12.04.02P	insert electrode into holder	electrode is inserted into holder according to operating procedures
C-12.04.03P	maintain electrode to work angle	electrode to work angle is maintained according to ***application***
C-12.04.04P	adjust carbon electrode stick-out during use	carbon electrode stick-out is adjusted during use according to manufacturers' recommendations
C-12.04.05P	maintain travel speed	travel speed is maintained according to ***application***
C-12.04.06P	identify ***defects*** after gouging	***defects*** are identified according to inspection after gouging
C-12.04.07P	clean material	material is cleaned after gouging using grinding techniques
C-12.04.08P	shut down ***CAC-A equipment***	***CAC-A equipment*** is shut down according to safe operating procedures and manufacturers' recommendations

Range of Variables

CAC-A equipment includes: power source, compressor
application includes: depth and width of gouge, cutting, removing material
defects include: copper and carbon deposits, poor gouge quality

Knowledge

	Learning Outcomes	Learning Objectives
C-12.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal metallurgy
		identify base metals that can and cannot be cut or gouged using CAC-A process

C-12.04.02L	demonstrate knowledge of procedures to cut and gouge using ***CAC-A equipment***, ***components*** and process	identify ***hazards***, and describe safe work practices pertaining to cutting and gouging using CAC-A process
		identify ***CAC-A equipment*** and ***components*** used to cut and gouge, and describe their procedures for use
		interpret and apply welding symbols and information pertaining to CAC-A process found on drawings and specifications
		describe procedures to cut and gouge material using CAC-A process
		describe procedures to adjust and maintain travel speed and torch angle
		describe procedures to identify ***defects*** after gouging
		describe procedures to clean material using grinding techniques
		describe procedures to shut down ***CAC-A equipment***
		describe procedures to control waste

Range of Variables

CAC-A equipment includes: power source, compressor
components include: hoses, electrode holder, cables, work lead clamp
hazards include: fumes, burns, sparks, electrical shocks, noise, radiation, molten material
defects include: copper and carbon deposits, poor gouge quality

Major Work Activity D
Performs welding processes

Task D-13 Welds using shielded metal arc welding (SMAW) process

Task Descriptor

SMAW is a commonly used process for joining most ferrous and some non-ferrous metals. Even though it is one of the slowest of the welding processes, it is readily available, easily accessible, very reliable, versatile and portable, and therefore it is widely used.

D-13.01 Selects SMAW equipment and consumables

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-13.01.01P	select ***power source***	***power source*** is selected according to application and primary power supply availability
D-13.01.02P	select electrode type and diameter	electrode type and diameter are selected according to base metal thickness and composition, joint type and position, and WPS/WPDS to ensure fusion and avoid weld discontinuities
D-13.01.03P	select ***components***	***components*** are selected according to application

Range of Variables

power source [constant current (CC) capable] includes: inverters, rectifiers, generators, transformers
components include: work lead clamps, electrode holders, cables, remote controls

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-13.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that can and cannot be welded using SMAW equipment

		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-13.01.02L	demonstrate knowledge of SMAW processes, equipment, ***components*** consumables, and their characteristics, applications and operation	describe fundamentals of SMAW process
		identify ***power sources***, and describe their characteristics and applications
		identify SMAW equipment, ***components*** and consumables, and describe their characteristics and applications
		describe storage requirements for SMAW electrodes
		identify SMAW electrodes, and describe their ***classifications***, ***characteristics, flux coating composition***, and applications
		identify ***components***, and describe their characteristics and applications
		describe operating principles of SMAW equipment
		interpret and apply welding symbols and information pertaining to SMAW equipment, ***components*** and consumables found on drawings and specifications
D-13.01.03L	demonstrate knowledge of training and qualification requirements for SMAW	identify training and qualification requirements for SMAW
		identify training and certification requirements and limitations pertaining to setting up primary wiring for SMAW equipment
D-13.01.04L	demonstrate knowledge of regulatory requirements pertaining to SMAW equipment, ***components*** and consumables	identify codes, standards and regulations pertaining to SMAW equipment, ***components*** and consumables

Range of Variables

components include: work lead clamps, electrode holders, cables, remote controls

power source [constant current (CC) capable] includes: inverters, rectifiers, generators, transformers

classifications include: American Welding Society (AWS), Canadian Standards Association (CSA), American Society of Mechanical Engineers (ASME), (tensile strength, position, composition, F-numbers)

characteristics include: tensile strength, position, composition, fast freezing, fast fill, freeze fill

flux coating composition includes: rutile (titania), cellulose, low-hydrogen (basic), iron-powder

D-13.02 Sets up SMAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
D-13.02.01P	identify damage and defects in SMAW equipment and ***components***	damage and defects in SMAW equipment and ***components*** are identified
D-13.02.02P	select machine settings on ***power source***	machine settings on ***power source*** are selected according to SMAW process
D-13.02.03P	set required current type	required current type is set by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-13.02.04P	connect electrode holders (stingers) and work lead clamps to cables	electrode holders (stingers) and work lead clamps are connected to cables
D-13.02.05P	attach work lead clamp to base metal	work lead clamp is attached to base metal to complete circuit
D-13.02.06P	verify setup	setup is verified by welding a test specimen of same base metal, electrode and position

Range of Variables

components include: work lead clamps, electrode holders, cables, remote controls
power source (CC capable) includes: inverters, rectifiers, generators, transformers

Knowledge

	Learning Outcomes	Learning Objectives
D-13.02.01L	demonstrate knowledge of SMAW processes, equipment, ***components*** and their characteristics, applications and operation	describe fundamentals of SMAW process
		identify ***power sources***, and describe their characteristics and applications
		identify SMAW equipment and ***components*** and describe their characteristics and applications
		describe operating principles of SMAW equipment
		describe procedures to refuel and perform general maintenance checks of engine-driven power sources

Range of Variables

components include: work lead clamps, electrode holders, cables, remote controls
power source (CC capable) includes: inverters, rectifiers, generators, transformers

D-13.03 Sets operating parameters for SMAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-13.03.01P	determine parameters	parameters are determined according to WPS/WPDS and application
D-13.03.02P	set/adjust amperage	amperage is set/adjusted according to base metal thickness and electrode type and size
D-13.03.03P	set and adjust additional ***machine options***	additional ***machine options*** are set and adjusted according to application
D-13.03.04P	verify setup	setup is verified by welding a test specimen of same base metal, electrode and position

Range of Variables

machine options include: arc force (dig), hot start

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-13.03.01L	demonstrate knowledge of SMAW processes, equipment, ***components*** and their characteristics, applications and operation	describe fundamentals of SMAW process
		identify SMAW equipment and ***components*** and describe their characteristics and applications
		identify ***power sources***, and describe their characteristics and applications
		identify welding ***components***, and describe their characteristics and applications
		describe operating principles of SMAW equipment

		interpret and apply welding symbols and information pertaining to SMAW equipment found on drawings and specifications
		describe metric and imperial electrode designations
D-13.03.02L	demonstrate knowledge of procedures to set operating parameters for SMAW equipment	identify ***hazards***, and describe safe work practices pertaining to setting operating parameters for SMAW equipment
		describe procedures to set operating parameters for SMAW equipment
		describe procedures to set/adjust additional ***machine options*** for SMAW equipment

Range of Variables

components include: work lead clamps, electrode holders, cables, remote controls

power source (CC capable) includes: inverters, rectifiers, generators, transformers

hazards include: fumes, electrical shocks, ultraviolet (UV) and infrared light, visible light rays, burns, flying debris

machine options include: arc force (dig), hot start

D-13.04 Performs weld using SMAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-13.04.01P	start up equipment	equipment is started up according to safe operating procedures and manufacturers' recommendations
D-13.04.02P	strike arc and manipulate electrode	arc is struck and electrode is manipulated while maintaining arc length, electrode angle and travel speed
D-13.04.03P	perform ***electrode manipulation techniques***	***electrode manipulation techniques*** are performed
D-13.04.04P	perform tacking, backstepping and sequencing techniques	tacking, backstepping and sequencing techniques are performed according to application, and controlling heat distortion
D-13.04.05P	adjust travel speed and angle	travel speed and angle are adjusted taking into consideration ***factors*** to maintain a consistent weld profile
D-13.04.06P	stop arc	arc is stopped ensuring proper tie-ins and avoiding weld discontinuities

D-13.04.07P	remove slag using ***tools***	slag is removed using ***tools***
D-13.04.08P	identify weld discontinuities	weld discontinuities are identified by performing visual inspection
D-13.04.09P	determine cause of weld discontinuities and defects	cause of weld discontinuities and defects are determined by troubleshooting SMAW equipment, process and ***electrode manipulation techniques***
D-13.04.10P	repair weld discontinuities	weld discontinuities are repaired by grinding/gouging and re-welding
D-13.04.11P	re-start arc	arc is re-started ensuring proper tie-ins and avoiding weld discontinuities and defects
D-13.04.12P	finish weld	weld is finished showing proper tie-ins in all positions and containing no unacceptable weld discontinuities and defects
D-13.04.13P	shut down equipment	equipment is shut down according to safe operating procedures and manufacturers' recommendations

Range of Variables

electrode manipulation techniques include: whip, using backhand and forehand techniques to achieve desired bead width and shape (weave and stringer) to direct heat; and control penetration and build-up

factors include: base metal, joint configuration, position, heat input, WPS/WPDS

tools include: wire wheels, chipping hammers, wire brushes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-13.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that can and cannot be welded using SMAW process
		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-13.04.02L	demonstrate knowledge of procedures to weld using SMAW equipment	identify ***hazards***, and describe safe work practices pertaining to welding using SMAW equipment
		identify SMAW equipment used to weld, and describe their procedures for use
		identify ***types of welds***, and describe their characteristics and applications
		describe procedures to start up and shut down equipment

		describe ***electrode manipulation techniques***
		identify SMAW electrodes, and describe their ***classifications***, ***characteristics, flux coating composition***, and applications
		identify ***weld position***
		identify ***joint configurations***
		identify ***electrical characteristics***
		describe procedures to maintain travel speed, electrode angle and heat inputs
		describe pre-heating, post-heating and interpass temperature requirements for base metals
		describe techniques to repair weld discontinuities and defects
		describe procedures to control waste and recycle SMAW equipment, components and consumables
D-13.04.03L	demonstrate knowledge of training and qualification requirements to weld using SMAW equipment	identify training and qualification requirements to weld using SMAW equipment
D-13.04.04L	demonstrate knowledge of regulatory requirements pertaining to welding using SMAW process	identify codes, standards and regulations pertaining to welding using SMAW process

Range of Variables

hazards include: burns, flying debris, fumes, falling objects, fire hazards, falling hazards, UV and infrared light, visible light rays

types of welds include: fillet, groove, plug, slot, surfacing

electrode manipulation techniques include: whip, using backhand and forehand techniques to achieve desired bead width and shape (weave and stringer) to direct heat; and control penetration and build-up

classifications include: AWS, CSA, ASME, (tensile strength, position, composition, F-numbers)

characteristics include: tensile strength, position, composition, fast freezing, fast fill, freeze fill

flux coating composition includes: rutile (titania), cellulose, low-hydrogen (basic), iron-powder

weld position includes: flat, horizontal, vertical, overhead, 1G, 2G, 5G, 6G

joint configurations include: butt, tee, edge, corner, lap

electrical characteristics include: current type, duty cycle, amperage

Task D-14 Welds using flux cored arc welding (FCAW), metal cored arc welding (MCAW) and gas metal arc welding (GMAW) processes

Task Descriptor

The FCAW is a semi-automatic process that uses tubular wire with a granular flux core, which can be gas shielded or self shielded. It is widely used in production shops because, compared to SMAW and GTAW processes, it has high productivity, low operating cost and high efficiency.

The MCAW process uses a tubular wire with a powdered metal core. Some of the advantages of this process include no slag produced, very little spatter and interpass cleaning required, and a very high deposition rate. It is used in similar applications as the FCAW process.

The GMAW process uses solid wire for welding metals and their alloys. It is used for applications such as sheet metal, structural steel and piping. It has a low distortion rate, a high deposition rate and requires minimal cleaning.

These processes typically use a constant voltage (CV) power source and a wire feeder that supplies continuously fed wire.

D-14.01 Selects FCAW, MCAW and GMAW gas, equipment and consumables

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-14.01.01P	select ***power source***	***power source*** is selected according to application and primary power supply availability
D-14.01.02P	select ***wire type*** and diameter	***wire type*** and diameter are selected according to base metal thickness and composition, joint type and position and WPS/WPDS to ensure fusion and avoid weld discontinuities
D-14.01.03P	select FCAW, MCAW and GMAW ***equipment and components***	FCAW, MCAW and GMAW ***equipment and components*** are selected according to application
D-14.01.04P	select ***shielding gas***	***shielding gas*** is selected according to ***factors***

Range of Variables

power sources include: CV capable machines (inverters, rectifiers, generator); constant current (CC) machine with voltage sensing wire feeder

wire type includes: solid and tubular wire, self-shielded

equipment and components include: guns (air-cooled, water-cooled), nozzles, contact tips, wire feeders, drive rolls, gas diffusers, liners, work lead clamps, regulators/flow meters, gas lines

shielding gas includes: CO_2, argon, helium, mixed gases

factors include: base metal composition, process, WPS/WPDS, mode of transfer, position, density-to-air ratio

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-14.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that can and cannot be welded using FCAW, MCAW and GMAW processes
		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-14.01.02L	demonstrate knowledge of FCAW, MCAW and GMAW processes, gas, ***equipment, components*** and consumables, and their, characteristics, applications and operation	describe fundamentals of FCAW, MCAW and GMAW processes
		identify FCAW, MCAW and GMAW ***equipment and components***, and describe their characteristics and applications
		identify FCAW, MCAW and GMAW ***wires*** and describe their characteristics and applications
		identify ***shielding gases***, and describe their characteristics and applications
		identify ***power sources***, and describe their characteristics and applications
		describe operating principles of FCAW, MCAW and GMAW equipment
		describe ***digital technology*** used in FCAW, MCAW and GMAW processes

Range of Variables

equipment and components include: guns (air-cooled, water-cooled), nozzles, contact tips, wire feeders, drive rolls, gas diffusers, liners, work lead clamps, regulators/flow meters, gas lines

wire type includes: solid and tubular wire, self-shielded

shielding gas includes: CO_2, argon, helium, mixed gases

power sources include: CV capable machines (inverters, rectifiers, generator); constant current (CC) machine with voltage sensing wire feeder

digital technology includes: waveform programming, real-time monitoring, pre-sets

D-14.02 Sets up FCAW, MCAW and GMAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-14.02.01P	identify damage and defects in FCAW, MCAW and GMAW equipment	damage and defects in FCAW, MCAW and GMAW equipment are identified
D-14.02.02P	set machine settings	machine settings are set according to FCAW, MCAW and GMAW process
D-14.02.03P	set required current type	required current type is set by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-14.02.04P	assemble ***gun components*** and connect gun to wire feeder	***gun components*** are assembled and gun is connected to wire feeder
D-14.02.05P	connect regulator to gas supply and gas hose to wire feeder	regulator is connected to gas supply and gas hose to wire feeder according to electrode selection
D-14.02.06P	install wire roll in wire feeder	wire roll is installed in wire feeder
D-14.02.07P	feed wire through drive rolls, liner and gun, and clip end of wire for appropriate stick-out	wire is fed through drive rolls, liner and gun, and end of wire is clipped for appropriate stick-out according to manufacturers' specifications
D-14.02.08P	adjust wire drive roll tension	wire drive roll tension is adjusted according to manufacturers' specifications to achieve a consistent rate of wire feed
D-14.02.09P	attach work lead clamp to base metal	work lead clamp is attached to base metal to complete circuit
D-14.02.10P	verify setup	setup is verified by welding a test specimen of same base metal, electrode and position

Range of Variables

gun components include: gas diffusers, contact tips, nozzles

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-14.02.01L	demonstrate knowledge of FCAW, MCAW and GMAW processes, gas, ***equipment, components*** and consumables, and their, characteristics, applications and operation	describe fundamentals of FCAW, MCAW and GMAW processes
		identify ***power source***
		identify FCAW, MCAW and GMAW ***equipment and components***, and describe their characteristics and applications
		identify ***types of wire*** for FCAW, MCAW and GMAW processes and describe their characteristics and applications
		identify ***shielding gases***, and describe their characteristics and applications
		identify ***power sources***, and describe their characteristics and applications
		describe operating principles of FCAW, MCAW and GMAW equipment
D-14.02.02L	demonstrate knowledge of procedures to set up FCAW, MCAW and GMAW ***equipment and components***	identify ***hazards***, and describe safe work practices pertaining to FCAW, MCAW and GMAW ***equipment and components***
		describe procedures to set up FCAW, MCAW and GMAW ***equipment and components***
		describe procedures to control waste and recycle FCAW, MCAW and GMAW ***equipment and components***
		describe ***digital technology*** used in FCAW, MCAW and GMAW processes
D-14.02.03L	demonstrate knowledge of training and qualification requirements pertaining to FCAW, MCAW and GMAW ***equipment and components***	identify training and qualification requirements pertaining to FCAW, MCAW and GMAW ***equipment and components***
		identify training and certification requirements and limitations pertaining to setting up primary wiring for FCAW, MCAW and GMAW equipment
D-14.02.04L	demonstrate knowledge of regulatory requirements pertaining to FCAW, MCAW and GMAW ***equipment and components***	identify codes, standards and regulations pertaining to FCAW, MCAW and GMAW ***equipment and components***

Range of Variables

equipment and components include: guns (air-cooled, water-cooled), nozzles, contact tips, wire feeders, drive rolls, gas diffusers, liners, work lead clamps, regulators/flow meters, gas lines

power sources include: CV capable machines (inverters, rectifiers, generator); CC machine with voltage sensing wire feeder

types of wire include: solid and tubular wire, self-shielded

shielding gases include: CO_2, argon, helium, mixed gases

hazards include: pinch points, burns, electrical burns, electrical shocks, falling objects, moving parts, asphyxiation, ozone and phosgene gases, UV and infrared light, visible light rays

digital technology includes: waveform programming, real-time monitoring, pre-sets

D-14.03 Sets operating parameters for FCAW, MCAW and GMAW

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-14.03.01P	determine parameters	parameters are determined according to WPS/WPDS and application
D-14.03.02P	set wire feed speed and voltage	wire feed speed and voltage are set according to WPS/WPDS and application
D-14.03.03P	set gas flow rate	gas flow rate is set according to WPS/WPDS and application
D-14.03.04P	verify setup	setup is verified by welding a test specimen of same base metal, electrode and position

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-14.03.01L	demonstrate knowledge of FCAW, MCAW and GMAW processes, ***equipment, components***, and their characteristics, applications and operation	describe fundamentals of FCAW, MCAW and GMAW processes
		identify FCAW, MCAW and GMAW ***equipment and components***, and describe their characteristics and applications
		describe operating principles of FCAW, MCAW and GMAW equipment
		interpret and apply welding symbols and information pertaining to FCAW, MCAW and GMAW equipment found on drawings and specifications

		describe metric and imperial electrode designations
D-14.03.02L	demonstrate knowledge of procedures to set operating parameters for FCAW, MCAW and GMAW equipment	identify ***hazards***, and describe safe work practices pertaining to setting operating parameters for FCAW, MCAW and GMAW equipment
		describe procedures to set operating parameters for FCAW, MCAW and GMAW equipment
		identify ***modes of transfer***
		identify operational working pressures
		describe ***digital technology*** used in FCAW, MCAW and GMAW processes

Range of Variables

equipment and components include: guns (air-cooled, water-cooled), nozzles, contact tips, wire feeders, drive rolls, gas diffusers, liners, work lead clamps, regulators/flow meters, gas lines

hazards include: burns, electrical burns, electrical shocks, moving parts, asphyxiation, fumes, ozone and phosgene gases, UV and infrared light, visible light rays

modes of transfer include: short circuit, globular, spray, pulse spray

digital technology includes: waveform programming, real-time monitoring, pre-sets

D-14.04 Performs weld using FCAW, MCAW and GMAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-14.04.01P	start up equipment	equipment is started up according to safe operating procedures and manufacturers' recommendations
D-14.04.02P	start arc and manipulate electrode	arc is started and electrode is manipulated while maintaining electrode angle and travel speed
D-14.04.03P	perform ***wire manipulation techniques***	***wire manipulation techniques*** are performed
D-14.04.04P	perform ***tacking***, backstepping and sequencing techniques	***tacking***, backstepping and sequencing techniques are performed according to application and code, and controlling heat distortion
D-14.04.05P	adjust travel speed and angle	travel speed and angle are adjusted taking into consideration ***factors*** to maintain a consistent weld profile

D-14.04.06P	stop arc	arc is stopped ensuring proper tie-ins and avoiding weld discontinuities
D-14.04.07P	remove slag using ***tools***	slag is removed using ***tools***
D-14.04.08P	identify weld discontinuities and defects	weld discontinuities and defects are identified by performing visual inspection
D-14.04.09P	determine cause of weld discontinuities and defects	cause of weld discontinuities and defects are determined by troubleshooting FCAW, MCAW and GMAW equipment, process and ***wire manipulation techniques***
D-14.04.10P	repair weld discontinuities and defects	weld discontinuities and defects are repaired by grinding/gouging and re-welding
D-14.04.11P	re-start arc	arc is re-started ensuring proper tie-ins and avoiding weld discontinuities
D-14.04.12P	finish weld	weld is finished showing proper tie-ins in all positions and containing no unacceptable welding discontinuities
D-14.04.13P	shut down equipment	equipment is shut down according to safe operating procedures and manufacturers' recommendations

Range of Variables

wire manipulation techniques include: using backhand and forehand techniques to achieve desired bead width and shape (weave and stringer) to direct heat, and control penetration and build-up

tacking includes: penetrating, bridge

factors include: base metal, joint configuration, position, heat input, WPS/WPDS

tools include: wire wheels, chipping hammers, wire brushes, grinding discs, air chippers, needle guns

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-14.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that can and cannot be welded using GMAW, MCAW and FCAW processes
		identify ferrous and non-ferrous metals, and describe their characteristics and applications

D-14.04.02L	demonstrate knowledge of procedures to weld using GMAW, MCAW and FCAW equipment	identify ***hazards***, and describe safe work practices pertaining to welding using GMAW, MCAW and FCAW equipment
		identify GMAW, MCAW and FCAW equipment used to weld, and describe their procedures for use
		identify ***types of welds***, and describe their characteristics and applications
		describe procedures to start up and shut down equipment
		describe ***wire manipulation techniques***
		identify GMAW, MCAW and FCAW electrodes, and describe their ***classifications***, ***characteristics***, ***flux composition*** and applications
		identify ***weld position***
		identify ***joint configurations***
		identify ***electrical characteristics***
		identify ***modes of transfer***
		describe procedures to maintain travel speed, electrode angle and heat inputs
		describe pre-heating, post-heating and interpass temperature requirements for base metals
		describe techniques to repair weld discontinuities
		describe procedures to control waste and recycle GMAW, MCAW and FCAW equipment, components and consumables
D-14.04.03L	demonstrate knowledge of training and qualification requirements to weld using GMAW, MCAW and FCAW equipment	identify training and qualification requirements to weld using GMAW, MCAW and FCAW equipment
D-14.04.04L	demonstrate knowledge of regulatory requirements pertaining to welding using GMAW, MCAW and FCAW processes	identify codes, standards and regulations pertaining to welding using GMAW, MCAW and FCAW processes

Range of Variables

hazards include: burns, flying debris, fumes, falling objects, fire hazards, falling hazards, UV and infrared light, visible light rays

types of welds include: fillet, groove, plug, slot, surfacing

wire manipulation techniques include: using backhand and forehand techniques to achieve desired bead width and shape (weave and stringer) to direct heat, and control penetration and build-up

classifications include: AWS, CSA, ASME, (tensile strength, position, composition, F-numbers)

characteristics include: tensile strength, position, composition
flux composition (MCAW, FCAW) includes: rutile, low-hydrogen (basic)
weld position includes: flat, horizontal, vertical, overhead
joint configurations include: butt, tee, edge, corner, lap
electrical characteristics include: current type, wire feed speed (amperage), voltage
modes of transfer include: short circuit, globular, spray, pulse spray

Task D-15 Welds using gas tungsten arc welding (GTAW) process

Task Descriptor

The GTAW process uses a non-consumable tungsten electrode and may include the use of a hand-fed filler rod. It provides high quality welds and requires minimal clean-up. It welds most ferrous and non-ferrous metals. It requires the most dexterity of all welding processes.

D-15.01 Selects GTAW gas, equipment and consumables

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-15.01.01P	select ***power source***	***power source*** is selected according to application and primary power supply availability
D-15.01.02P	select GTAW gas, ***equipment***, ***components*** and consumables	GTAW gas, ***equipment***, ***components*** and consumables are selected according to ***factors*** and application
D-15.01.03P	select ***shielding gas***	***shielding gas*** is selected taking into consideration ***factors***
D-15.01.04P	select purging equipment	purging equipment is selected according to application and base metal
D-15.01.05P	select ***tungsten electrode*** and filler rod compositions and diameters	***tungsten electrode*** and filler rod compositions and diameters are selected taking into consideration base metal thickness and composition, joint type, position and WPS/WPDS to ensure fusion and avoid weld discontinuities

Range of Variables

power source (CC capable) includes: inverters, rectifiers, generators, transformers, high-frequency option, AC option

equipment and components include: tungsten electrodes, gas lenses, collets, collet bodies, work lead clamps, torches and cables (leads), regulators/flow meters, shielding gases, hoses, water coolers, remote controls, cups

factors (for selecting equipment and components) include: joint type, shielding gas, base metal, welding position, WPS/WPDS

shielding gas includes: argon, helium, mixed gases

factors (for selecting shielding gas) include: base metal composition, WPS/WPDS, welding position

tungsten electrodes include: pure, thoriated, zirconiated, lanthanated, ceriated, rare earth

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-15.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that have specialized applications for using GTAW equipment
		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-15.01.02L	demonstrate knowledge of GTAW processes, gas, ***equipment, components*** and consumables, and their characteristics, applications and operation	describe fundamentals of GTAW process
		identify GTAW ***equipment and components***, and describe their characteristics and applications
		identify types of ***tungsten electrodes*** and filler rod, and describe their characteristics and applications
		identify ***shielding gases***, and describe their characteristics and applications
		identify ***power sources***, and describe their characteristics and applications
		identify purging equipment, and describe their characteristics and applications
		describe operating principles of GTAW equipment
		describe ***digital technology*** used in GTAW processes

Range of Variables

equipment and components include: tungsten electrodes, gas lenses, collets, collet bodies, work lead clamps, torches and cables (leads), regulators/flow meters, shielding gases, hoses, water coolers, remote controls, cups

tungsten electrodes include: pure, thoriated, zirconiated, lanthanated, ceriated, rare earth

shielding gas includes: argon, helium, mixed gases

power source (CC capable) includes: inverters, rectifiers, generators, transformers, high-frequency option, AC option

digital technology includes: waveform programming, real-time monitoring, pre-sets

D-15.02 Sets up GTAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-15.02.01P	identify damage and defects in GTAW ***equipment and components***	damage and defects in GTAW ***equipment and components*** are identified
D-15.02.02P	set ***machine settings***	***machine settings*** are set according to GTAW process and high frequency settings used according to application and WPS
D-15.02.03P	connect work lead clamp and torch to power source	work lead clamp and torch are connected to power source
D-15.02.04P	connect regulator/flow meter to gas supply and hoses	regulator/flow meter is connected to gas supply and hoses
D-15.02.05P	assemble ***equipment and components*** and connect assembly to power source	***equipment and components*** are assembled and assembly is connected to power source
D-15.02.06P	shape end of ***tungsten electrode*** and adjust stick-out	end of ***tungsten electrode*** is shaped and stick-out is adjusted according to joint configuration and base metal
D-15.02.07P	attach work lead clamp to base metal	work lead clamp is attached to base metal to complete circuit
D-15.02.08P	dam and purge weld area	weld area is dammed and purged taking into consideration ***factors***
D-15.02.09P	verify setup	setup is verified by welding a test specimen of same base metal, electrode filler metal and position

Range of Variables

equipment and components include: tungsten electrodes, gas lenses, collets, collet bodies, work lead clamps, torches and cables (leads), regulators/flow meters, shielding gases, hoses, water coolers, remote controls, cups

machine settings include: AC, DC, scratch start, lift start, high frequency start, pre-purge, post purge pulse, AC balance, AC frequency, AC for sine wave, amperage, current type

tungsten electrodes include: pure, thoriated, zirconiated, lanthanated, ceriated, rare earth blends

factors (for damming and purging work area) include: base metal composition, joint configuration, position, WPS/WPDS

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-15.02.01L	demonstrate knowledge of GTAW processes, gas, ***equipment, components*** and consumables, and their characteristics, applications and operation	describe fundamentals of GTAW processes
		identify ***power source***
		identify GTAW ***equipment and components***, and describe their characteristics and applications
		identify ***types of torches***, and describe their components, characteristics and applications
		identify types of regulators/flow meters, cylinders and hoses, and describe their characteristics and applications
		identify ***types of filler metals***, and describe their classifications, characteristics and applications
		identify types of ***tungsten electrodes***, and describe their colour codes, characteristics and applications
		describe operating principles of GTAW ***equipment and components***
D-15.02.02L	demonstrate knowledge of procedures to set up GTAW ***equipment and components***	identify ***hazards***, and describe safe work practices pertaining to GTAW ***equipment and components***
		describe procedures to set up GTAW ***equipment and components***
		describe procedures to control waste and recycle GTAW ***equipment and components***
		describe damming and purging methods and applications
		describe procedures to refuel and perform general maintenance checks of engine-driven power sources

		describe ***digital technology*** used in GTAW processes
D-15.02.03L	demonstrate knowledge of training and qualification requirements pertaining to GTAW ***equipment and components***	identify training and qualification requirements pertaining to GTAW ***equipment and components***
D-15.02.04L	demonstrate knowledge of regulatory requirements pertaining to GTAW ***equipment and components***	identify codes, standards and regulations pertaining to GTAW ***equipment and components***

Range of Variables

equipment and components include: tungsten electrodes, gas lenses, collets, collet bodies, work lead clamps, torches and cables (leads), regulators/flow meters, shielding gases, hoses, water coolers, remote controls, cups

power source (CC capable) includes: inverters, rectifiers, generators, transformers, high-frequency option, AC option

types of torches include: air-cooled and liquid-cooled

types of filler metals include: rods, wire, consumable inserts

tungsten electrodes include: pure, thoriated, zirconiated, lanthanated, ceriated, rare earth blends

hazards include: burns, fumes, hazardous gases, falling objects, fire hazards, falling hazards, electromagnetic field (EMF), UV and infrared light, visible light rays, radiation

digital technology includes: waveform programming, real-time monitoring, pre-sets

D-15.03 Sets operating parameters for GTAW

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-15.03.01P	determine parameters	parameters are determined according to WPS/WPDS and application
D-15.03.02P	set amperage, current type and frequency to match parameters	amperage, current type and frequency are set to match parameters according to base metal type and thickness, size and composition of filler metal, and position of weld
D-15.03.03P	set shielding gas flow rate including pre- and post-flow time	shielding gas flow rate, including pre- and post-flow time, is set according to WPS/WPDS and application
D-15.03.04P	set up damming and purging	damming and purging is set up according to WPS/WPDS, application and base metal
D-15.03.05P	verify setup	setup is verified by welding a test specimen of same base metal, electrode filler metal and position

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-15.03.01L	demonstrate knowledge of GTAW processes, gas, ***equipment, components*** and consumables, and their characteristics, applications and operation	describe fundamentals of GTAW processes
		identify GTAW ***equipment and components***, and describe their characteristics and applications
		describe operating principles of GTAW equipment
		interpret and apply welding symbols and information pertaining to GTAW equipment found on drawings and specifications
		describe metric and imperial designations
D-15.03.02L	demonstrate knowledge of procedures to set operating parameters for GTAW equipment	identify ***hazards***, and describe safe work practices pertaining to setting operating parameters for GTAW equipment
		describe procedures to set operating parameters for GTAW equipment
		identify ***amperage controls***, and describe their characteristics and applications
		identify ***start options***
		identify AC balance
		identify current type
		identify operational working pressures and flow rates
		describe ***digital technology*** used in GTAW processes

Range of Variables

equipment and components include: tungsten electrodes, gas lenses, collets, collet bodies, work lead clamps, torches and cables (leads), regulators/flow meters, shielding gases, hoses, water coolers, remote controls, cups

hazards include: burns, fumes, hazardous gases, falling objects, fire hazards, falling hazards, electromagnetic field (EMF), UV and infrared light, visible light rays

amperage controls include: foot pedal, thumb control, remote, power source controls

start options include: scratch start, lift arc, high frequency

digital technology includes: waveform programming, real-time monitoring, pre-sets, frequency, pulse

D-15.04 Performs weld using GTAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
D-15.04.01P	start up equipment	equipment is started up according to safe operating procedures and manufacturers' recommendations
D-15.04.02P	clean base metal and filler metal	base metal and filler metal are cleaned according to manufacturers' specifications and recommendations, material and safe work practices
D-15.04.03P	start arc, and manipulate tungsten electrode (torch) and filler metal	arc is started, and tungsten electrode (torch) and filler metal are manipulated while maintaining arc length, angles, and travel speed
D-15.04.04P	adjust amperage	amperage is adjusted with ***amperage controls***
D-15.04.05P	perform ***torch manipulation techniques*** and filler metal manipulation techniques	***torch manipulation techniques*** and filler metal manipulation techniques are performed
D-15.04.06P	perform ***tacking***, backstepping and sequencing techniques	***tacking***, backstepping and sequencing techniques are performed according to application and code, and controlling heat distortion
D-15.04.07P	adjust travel speed and angle	travel speed and angle are adjusted taking into consideration ***factors*** to maintain a consistent weld profile
D-15.04.08P	stop arc	arc is stopped ensuring proper tie-ins and avoiding weld discontinuities
D-15.04.09P	clean welded areas using ***tools***	welding areas are cleaned using ***tools*** according to application
D-15.04.10P	identify weld discontinuities and defects	weld discontinuities and defects are identified by performing visual inspection
D-15.04.11P	determine cause of weld discontinuities and defects	cause of weld discontinuities and defects are determined by troubleshooting GTAW equipment, process, ***torch manipulation techniques*** and filler metal manipulation techniques
D-15.04.12P	repair weld discontinuities and defects	weld discontinuities and defects are repaired by grinding/gouging and re-welding

D-15.04.13P	re-start arc	arc is re-started ensuring proper tie-ins and avoiding weld discontinuities
D-15.04.14P	finish weld	weld is finished showing proper tie-ins in all positions and containing no unacceptable weld discontinuities
D-15.04.15P	shut down equipment	equipment is shut down according to safe operating procedures and manufacturers' recommendations

Range of Variables

amperage controls include: foot pedal, thumb control, remote, power source controls

torch manipulation techniques include: walking the cup; forehand and backhand to achieve desired bead width and shape (weave and stringer)

tacking includes: penetrating, bridge

factors include: base metal, joint configuration, position, heat input, filler metal, WPS/WPDS

tools include: wire wheels, wire brushes, chemical cleaners

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-15.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that have specialized applications for using GTAW process
		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-15.04.02L	demonstrate knowledge of procedures to weld using GTAW ***equipment and components***	identify ***hazards***, and describe safe work practices pertaining to welding using GTAW equipment
		identify GTAW ***equipment and components*** used to weld, and describe their procedures for use
		identify ***specialized GTAW equipment***
		identify ***types of welds***, and describe their characteristics and applications
		describe procedures to start up and shut down equipment
		describe autogenous (no filler) welding technique
		describe ***torch manipulation techniques***
		describe pre- and post-flow shielding
		describe storage requirements for filler rods

		identify GTAW filler metals, and describe their ***classifications***, ***characteristics,*** and applications
		identify ***weld position***
		identify ***joint configurations***
		identify ***electrical characteristics***
		describe procedures to maintain travel speed, electrode angle and heat inputs
		describe amperage requirements
		describe pre-heating, post-heating and interpass temperature requirements for base metals
		describe techniques to repair weld discontinuities
		describe procedures to control waste and recycle GTAW equipment, components and consumables
D-15.04.03L	demonstrate knowledge of training and qualification requirements to weld using GTAW equipment	identify training and qualification requirements to weld using GTAW equipment
D-15.04.04L	demonstrate knowledge of regulatory requirements pertaining to welding using GTAW process	identify codes, standards and regulations pertaining to welding using GTAW process

Range of Variables

equipment and components include: tungsten electrodes, gas lenses, collets, collet bodies, work lead clamps, torches and cables (leads), regulators/flow meters, shielding gases, hoses, water coolers, remote controls, cups

hazards include: burns, fumes, hazardous gases, falling objects, fire hazards, falling hazards, EMF, UV and infrared light, visible light rays, radioactivity (thoriated tungsten)

specialized GTAW equipment includes: robotic welders, orbital welders, automatic machines, semi-automatic machines, hot wire

types of welds include: fillet, groove, plug, slot, surfacing

torch manipulation techniques include: walking the cup; forehand and backhand to achieve desired bead width and shape (weave and stringer)

classifications include: AWS, CSA, ASME, (tensile strength, position, composition, F-numbers)

characteristics include: tensile strength, position, composition

weld position includes: flat, horizontal, vertical, overhead, 1G, 2G, 3G, 4G, 5G, 6G

joint configurations include: butt, tee, edge, corner, lap

electrical characteristics include: current type, duty cycle, amperage

Task D-16 Welds using submerged arc welding (SAW) process

Task Descriptor

The SAW process provides the highest production rate. The most difficult part of this process is setting up the equipment. It is the only wire feed process that may use AC and DC currents concurrently.

This process is mostly used on large scale productions, including pressure vessels, tanks, bridges and ship construction.

D-16.01 Selects SAW equipment and consumables

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-16.01.01P	select ***power source***	***power source*** is selected according to application and primary power supply availability
D-16.01.02P	select electrode type and diameter	electrode type and diameter is selected according to base metal thickness and composition, joint type and position and WPS/WPDS to ensure fusion and avoid weld discontinuities
D-16.01.03P	select ***flux***	***flux*** is selected according to base metal thickness and composition, electrode selection, joint type and position and WPS/WPDS to ensure fusion and avoid weld discontinuities
D-16.01.04P	select SAW ***equipment and components***	SAW ***equipment and components*** are selected according to application

Range of Variables

power source includes: inverters, rectifiers, transformers

flux includes: fused, bonded, active, reactive, neutral

equipment and components include: drive rolls, contact tips, hoppers, work lead clamps, welding head and control system, cables, wire straightener, booms, tracks, flux recycling equipment

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-16.01.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that can and cannot be welded using SAW process
		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-16.01.02L	demonstrate knowledge of SAW processes, ***equipment***, ***components,*** consumables, and their characteristics, applications and operation	describe fundamentals of SAW process
		identify SAW ***equipment***, ***components*** and consumables, and describe their characteristics and applications
		identify ***power sources***, and describe their characteristics and applications
		identify SAW electrodes, and describe their ***classifications***, ***characteristics*** and applications
		identify ***flux*** and describe their characteristics and applications
		describe storage requirements for SAW electrodes and ***flux***
		describe operating principles of SAW equipment
		interpret and apply welding symbols and information pertaining to SAW ***equipment***, ***components*** and consumables found on drawings and specifications

Range of Variables

equipment and components include: drive rolls, contact tips, hoppers, work lead clamps, welding head and control system, cables, wire straightener, booms, tracks, flux recycling equipment

power source includes: inverters, rectifiers, transformers

classifications include: AWS, CSA, ASME, (tensile strength, position, composition, F-numbers)

characteristics include: tensile strength, position, composition

flux includes: fused, bonded, active, reactive, neutral

D-16.02 Sets up SAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-16.02.01P	identify damage and defects in SAW equipment	damage and defects in SAW equipment are identified
D-16.02.02P	select machine settings on ***power source(s)***	machine settings on ***power source(s)*** are selected according to SAW process
D-16.02.03P	connect cables (leads) to ***power source(s)*** and wire feeder	cables (leads) are connected to ***power source(s)*** and wire feeder
D-16.02.04P	assemble ***equipment and components***	***equipment and components*** are assembled
D-16.02.05P	adjust wire drive roll tension	wire drive roll tension is adjusted according to manufacturers' specifications to achieve a consistent rate of wire feed
D-16.02.06P	feed wire through liner, drive rolls, barrel and contact tip, and clip end of wire for appropriate stick-out	wire is fed through liner, drive rolls, barrel and contact tip, and end of wire is clipped for appropriate stick-out
D-16.02.07P	set required current type	required current type is set by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-16.02.08P	attach work lead clamp to base metal	work lead clamp is attached to base metal to complete circuit
D-16.02.09P	fill ***flux*** hopper	***flux*** hopper is full
D-16.02.10P	verify setup	setup is verified by ensuring tracking consistency and required travel speed

Range of Variables

power source(s) includes: inverters, rectifiers, transformers

equipment and components include: drive rolls, contact tips, hoppers, work lead clamps, welding head and control system, cables, wire straightener, booms, tracks, flux recycling equipment, demagnetizer, runoff tabs

flux includes: fused, bonded, active, reactive, neutral

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-16.02.01L	demonstrate knowledge of SAW processes, ***equipment***, ***components***, and their characteristics, applications and operation	identify SAW ***equipment and components***, and describe their characteristics and applications
		identify ***power source(s)***
		identify types of filler wire and flux combinations, and describe their ***classifications***, characteristics and applications
		describe operating principles of SAW ***equipment and components***
D-16.02.02L	demonstrate knowledge of procedures to set up SAW ***equipment and components***	identify ***hazards***, and describe safe work practices pertaining to SAW ***equipment and components***
		describe procedures to set up SAW ***equipment and components***
		identify multiple wire setups and polarities
		describe procedures to control waste and recycle SAW ***equipment*** and ***components***
		describe ***digital technology*** used in SAW processes
D-16.02.03L	demonstrate knowledge of training and qualification requirements pertaining to SAW ***equipment and components***	identify training and qualification requirements pertaining to SAW ***equipment and components***
		identify training and certification requirements and limitations pertaining to setting up primary wiring for SAW equipment
D-16.02.04L	demonstrate knowledge of regulatory requirements pertaining to SAW ***equipment and components***	identify codes, standards and regulations pertaining to SAW ***equipment and components***

Range of Variables

equipment and components include: drive rolls, contact tips, hoppers, work lead clamps, welding head and control system, cables, wire straightener, booms, tracks, flux recycling equipment, demagnetizer, runoff tabs

power source(s) includes: inverters, rectifiers, transformers

classifications (filler wire and flux) include: AWS, CSA, ASME, (tensile strength, composition)

hazards include: burns, fumes, hazardous gases, falling objects, fire hazards, falling hazards, slip hazards

digital technology includes: waveform programming, realtime monitoring, pre-sets, frequency

D-16.03 Sets operating parameters for SAW

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Skills

	Performance Criteria	Evidence of Attainment
D-16.03.01P	determine parameters	parameters are determined according to WPS/WPDS and application
D-16.03.02P	set/adjust amperage	amperage is set/adjusted according to WPS/WPDS, base metal and electrode selected
D-16.03.03P	set wire feed speed and voltage	wire feed speed and voltage are set according to WPS/WPDS, base metal type and thickness, size and composition of wire, position of weld and selection of gas
D-16.03.04P	set electrode stick-out	electrode stick-out is set according to WPS/WPDS and application
D-16.03.05P	set flux rate	flux rate is set according to WPS/WPDS and application
D-16.03.06P	set travel speed	travel speed is set according to WPS/WPDS and application
D-16.03.07P	verify setup	setup is verified by welding a test specimen of same base metal, electrode and position

Knowledge

	Learning Outcomes	Learning Objectives
D-16.03.01L	demonstrate knowledge of SAW processes, ***equipment***, ***components,*** consumables, and their characteristics, applications and operation	describe fundamentals of SAW processes
		identify SAW equipment, and describe their characteristics and applications
		describe operating principles of SAW equipment
		interpret and apply welding symbols and information pertaining to SAW equipment found on drawings and specifications
		describe metric and imperial electrode and flux designations

D-16.03.02L	demonstrate knowledge of procedures to set operating parameters for SAW equipment	identify ***hazards***, and describe safe work practices pertaining to setting operating parameters for SAW equipment
		describe procedures to set operating parameters for SAW equipment
		describe ***digital technology*** used in SAW processes

Range of Variables

equipment and components include: drive rolls, contact tips, hoppers, work lead clamps, welding head and control system, cables, wire straightener, booms, tracks, flux recycling equipment, demagnetizer, runoff tabs

hazards include: burns, fumes, hazardous gases, falling objects, fire hazards, falling hazards, slip hazards

digital technology includes: waveform programming, real-time monitoring, pre-sets, frequency

D-16.04 Performs weld using SAW equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-16.04.01P	start up equipment	equipment is started up according to safe operating procedures and manufacturers' recommendations
D-16.04.02P	adjust head height	head height is adjusted to maintain appropriate stick-out and to control flux coverage
D-16.04.03P	verify setup	setup is verified by performing a dry run to ensure tracking consistency
D-16.04.04P	initiate arc	arc is initiated by engaging wire feed, travel and current according to manufacturers' recommendations
D-16.04.05P	perform sequencing techniques	sequencing techniques are performed according to application, code, and controlling heat distortion
D-16.04.06P	monitor and adjust travel speed and angle	travel speed and angle are monitored and adjusted to maintain consistent tracking
D-16.04.07P	recover, filter and demagnetize flux	flux is recovered, filtered and demagnetized according to client requirements and manufacturers' specifications
D-16.04.08P	stop arc	arc is stopped ensuring proper tie-ins and avoiding weld discontinuities

D-16.04.09P	remove slag using ***tools***	slag is removed using ***tools***
D-16.04.10P	identify weld discontinuities and defects	weld discontinuities and defects are identified by performing visual inspection
D-16.04.11P	determine cause of weld discontinuities and defects	cause of weld discontinuities and defects are determined by troubleshooting SAW equipment and process
D-16.04.12P	repair weld discontinuities and defects	weld discontinuities and defects are repaired by grinding/gouging and re-welding
D-16.04.13P	finish weld	weld is finished showing proper tie-ins in all positions and containing no unacceptable weld discontinuities and defects
D-16.04.14P	shut down equipment	equipment is shut down according to safe operating procedures and manufacturers' recommendations

Range of Variables

tools include: wire wheels, chipping hammers, wire brushes, grinding discs, air chippers, needle guns

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-16.04.01L	demonstrate knowledge of base metals, their characteristics and applications	identify base metals, and describe their characteristics and applications
		describe base metal chemical composition and metallurgy
		identify base metals that can and cannot be welded using SAW process
		identify ferrous and non-ferrous metals, and describe their characteristics and applications
D-16.04.02L	demonstrate knowledge of procedures to weld using SAW ***equipment and components***	identify ***hazards***, and describe safe work practices pertaining to welding using SAW ***equipment and components***
		identify SAW ***equipment and components*** used to weld, and describe their procedures for use
		identify ***types of welds***, and describe their characteristics and applications
		describe procedures to start up and shut down equipment
		describe storage requirements for filler wire and ***flux***
		identify SAW electrodes, and describe their ***classifications***, ***characteristics***, and applications

		identify ***flux*** and describe its classifications, characteristics and applications
		identify ***weld position***
		identify ***joint configurations***
		identify ***electrical characteristics***
		identify multiple arc configurations
		describe procedures to maintain travel speed, stick-outs, angle and heat inputs
		describe pre-heating, post-heating and interpass temperature requirements for base metals
		describe techniques to repair weld discontinuities
		describe procedures to control waste and recycle SAW equipment, components and consumables
D-16.04.03L	demonstrate knowledge of training and qualification requirements to weld using SAW ***equipment and components***	identify training and qualification requirements to weld using SAW ***equipment and components***
D-16.04.04L	demonstrate knowledge of regulatory requirements pertaining to welding using SAW process	identify codes, standards and regulations pertaining to welding using SAW process

Range of Variables

equipment and components include: drive rolls, contact tips, hoppers, work lead clamps, welding head and control system, cables, wire straightener, booms, sub-arc tractors, tracks, flux recovery system, demagnetizer, runoff tabs

hazards include: burns, fumes, hazardous gases, falling objects, fire hazards, falling hazards, slip hazards, flux dust, moving equipment

types of welds include: fillet, groove, surfacing

flux includes: fused, bonded, active, reactive, neutral

classifications include: AWS, CSA, ASME, (tensile strength, position, composition, F-numbers)

characteristics include: tensile strength, position, composition

weld position includes: flat, horizontal

joint configurations include: butt, tee, surface build up

electrical characteristics include: current type, duty cycle, amperage

Appendix A
Acronyms

AC	alternating current
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
CAC	carbon arc cutting
CAC-A	air carbon arc cutting
CC	constant current
CSA	Canadian Standards Association
CV	constant voltage
DC	direct current
EMF	electromagnetic field
FCAW	flux cored arc welding
GMAW	gas metal arc welding
GTAW	gas tungsten arc welding
GTSM	grind to sound metal
ITP	inspection test plan
LOTO	lock out/tag out
MPS	methylacetylene-propadiene
MCAW	metal cored arc welding
MTR	mill test reports
OFC	oxy-fuel gas cutting
OH&S	Occupational Health and Safety
PAC	plasma arc cutting
PAPR	powered air purifying respirator
PPE	personal protective equipment
SAW	submerged arc welding
SDS	safety data sheet
SMAW	shielded metal arc welding
UV	ultraviolet
WHMIS	Workplace Hazardous Materials Information System
WPDS	Welding Procedures Data Sheets
WPS	Welding Procedures Specifications

Appendix B
Tools and Equipment / Outils et équipement

Hand Tools / Outils à main

adjustable wrenches (various sizes)	clés à molette (de diverses grandeurs)
aviation snips (left-cut, right-cut, straight-cut)	cisailles de type aviation (coupe à gauche, coupe à droite, coupe droite)
broom	balai
brushes (bristle, wire, paint)	brosses (brosses en soie, brosses métalliques, pinceaux)
chalk line	cordeau à craie
chisels (cold, diamond point, cape)	ciseaux (à froid, à pointe diamantée, bédane)
clamps (C, bar, pipe)	serres (en C, à coulisse, pour tuyau)
cylinder carts	chariots pour bouteilles
cylinder cradles	berceaux pour bouteilles
dollies	diables
drift pin (bull pin)	tige d'assemblage (tige d'alignement)
files (flat, half-round, rat-tail, bastard)	limes (plate, demi-ronde, queue-de-rat, bâtarde)
flashlight	lampe de poche
friction lighter	briquet à friction
funnels	entonnoirs
hacksaw	scie à métaux
hammers (chipping, ball peen, claw, sledge)	marteaux (burineur, à panne ronde, à panne fendue, masse)
hand shears	cisailles manuelles
hex wrenches (metric and imperial)	clés hexagonales (métriques et impériales)
hydraulic jack	vérin hydraulique
knives	couteaux
locking pliers	pinces-étaux
magnets	aimants
oil can	burette à huile
pails (plastic and metal)	seaux (en plastique et en métal)
pipe cutters	coupe-tuyaux
pipe wrap	isolant à tuyau
pipe wrenches	clés à tuyaux
pliers (needle nose, MIG, slip joint)	pinces (à bec effilé, MIG, à joint coulissant)
pry bars	leviers
punches (center, prick)	pointeaux (centreur, de traçage)
rollers	rouleaux

scrapers (various sizes)	grattoirs (de diverses grandeurs)
screwdrivers (flat, Phillips, Robertson; hex-head; various sizes)	tournevis (à tête plate, à pointe cruciforme, à pointe carrée, à pointe hexagonale; de diverses grandeurs)
shovels (flat mouth)	pelles (carrées)
soapstone markers	marqueurs en stéatite
socket sets (metric and imperial)	jeux de douilles (métriques et impériales)
soldering iron	fer à souder
stamping tools	outils à estamper
tip cleaners	nettoyeurs de buse
tool boxes	coffres à outils
vises (bench vise, chain vise)	étaux (d'établi, à chaîne)
water hose	boyau d'arrosage
wrench sets (open and closed ends; metric and imperial)	jeux de clés (ouvertes et polygonales; métriques et impériales)

Layout, Measuring and Testing Tools / Outils de traçage, de mesure et d'essai

ammeters	ampèremètres
bridge cam gauge	jauge de came de pont
calculators	calculatrices
calipers	compas d'épaisseur
combination square set	équerres combinées
depth gauges	jauges de profondeur
feeler gauges	jauges d'épaisseur
fillet gauges	calibres de soudure d'angle
hi-lo gauge	jauge de profondeur (hi-lo)
laser levels	niveaux au laser
leak testing supplies	matériaux pour les tests d'étanchéité
measuring tape	ruban à mesurer
micrometers	micromètres
plumb bobs	fils à plomb
pyrometers	pyromètres
radius marker	marqueur de rayon
ruler	règle
scribers	pointes à tracer
spirit levels	niveaux à bulle
squares	équerres
stair gauges	calibres de traçage
straight edges	règles de précision
temperature indicating crayons and pellets	crayons et pastilles thermosensibles
tri-square	équerre de menuisier

torpedo levels	niveaux torpilles
torque wrench	clé dynamométrique
trammel points	compas à verge
vernier calipers	pieds à coulisse
v-wac gauge	jauge de mesure v-wac

Power Tools and Equipment / Équipement et outils mécaniques

air chipper	marteau-burineur pneumatique
air hoses and nozzles	tuyaux d'air et buses
band saws	scies à ruban
buffers	polissoirs
chop saws (cut-off saws)	scies à tronçonner (ébouteuses)
circular saws	scies circulaires
coil heating equipment	équipement de chauffage par résistance
cold cut saws	scies à froid
communication devices (two-way radios, smart phones)	appareils de communication (radios avec émetteur-récepteur, téléphones intelligents)
compressors	compresseurs
drills (portable, hammer, electric, magnetic)	perceuses (portative, marteau-perforateur, électrique, magnétique)
extension cords	rallonges électriques
grinders (die, bench, pedestal, angle)	meuleuses (à rectifier les matrices, d'établi, sur socle, d'angle)
heating tips (rosebuds)	buses de chauffage
hydraulic press brake	presse-plieuse hydraulique
hydraulic rams	béliers hydrauliques
hydraulic shears	cisailles hydrauliques
hydrostatic equipment	équipement hydrostatique
impact wrenches (electric or pneumatic)	clés à chocs (électriques ou pneumatiques)
ironworkers	cisailles-poinçonneuses
needle gun	pistolet à aiguilles
nibblers	grignoteuses
pipe beveling machines	machines à biseauter les tuyaux
pipe cutters	coupe-tuyaux
pneumatic equipment	équipement pneumatique
portable heaters	appareils de chauffage portatifs
power hacksaws	scies à métaux électriques
power vises	étaux mécaniques
propane torch (tiger torch)	chalumeau à propane (buse de lance-flammes)

reamers (hand held or mounted on power threader)	alésoirs (à main ou monté sur filière mécanique)
reciprocating saws	scies alternatives
routers	toupies
sanders	ponceuses
vacuums (wet/dry)	aspirateurs (pour déchets secs et humides)
winches	treuils

Material Handling Equipment / Équipement de manutention

beam clamps	attaches de poutre
beam trolley	chariots à poutre
cable clamps	serre-câbles
chain block hoists	palans à chaîne
chains	chaînes
chokers	élingues à étranglement
cranes (overhead, gantry-type, monorail, boom)	grues (pont roulant, grue à portique, grue monorail, grue à flèche)
dunnage (blocking)	fardage (blocage)
forklifts	chariots élévateurs à fourche
jackstands	chandelles
lever hoists (come-alongs) (cable or chain)	palans (à câble ou à chaîne)
lifting rings	anneaux de levage
manual wire rope hoist	palan à main à câble d’acier
overhead hoists	palans suspendus
plate clamps	pinces à plaques
portable boom	flèche portative
rope	cordage
shackles	manilles
slings	élingues
softeners	protecteurs d’élingues
spreader bars	palonniers
tuggers	chariots tracteurs

Access Equipment / Équipement d’accès

aerial work platforms	plateformes de travail élévatrices
angel wing basket	nacelle (angel wing)
ladders	échelles
personnel basket	nacelle
scaffolding	échafaudage
scissor lifts	plateformes élévatrices à ciseaux
swing stage	échafaudage volant

Personal Protective Equipment and Safety Equipment / Équipement de protection individuelle et de sécurité

air hoods	cagoules à adduction d’air
air/gas monitoring devices	appareils de surveillance de l’air/des gaz
aprons	tabliers
body harness/lanyards	harnais/cordes de retenue
coveralls	combinaisons
ear-plugs and ear muffs	bouchons d’oreilles et cache-oreilles antibruit
face shields	écrans faciaux
fire blankets	couvertures ignifuges
fire extinguishers	extincteurs
fire hoses	boyaux d’incendie
fire retardant clothing	vêtement ignifuges
flashback arrestors	dispositifs antiretour de flamme
gloves	gants
goggles	lunettes-masque de protection
hard hats	casques de sécurité
masks (particle, vapour)	masques (contre les particules, contre les vapeurs)
powered air purifying respirator (PAPR)	respirateur filtrant à ventilation assistée
respirators	respirateurs
reverse-flow check valve	clapets anti-retour à écoulement inversé
safety boots	bottes de sécurité
safety glasses	lunettes de sécurité
welding shield	masque de soudeur

Cutting, Gouging and Welding Equipment / Équipement de coupage, de gougeage et de soudage

cable connectors	raccords de câble
electrode holders	porte-électrodes
electrode ovens	fours à électrodes
oxy-fuel cutting and welding equipment	équipement d’oxycoupage et de soudage à l’oxygaz
torches (GTAW, plasma, oxy-fuel, arc-air)	chalumeaux (GTAW, plasma, oxygaz, air-arc)
welding and plasma power sources	sources d’alimentation pour le soudage et le coupage au plasma
welding cables	câbles de soudage
welding guns	pistolets à souder
wire feeders	dévidoirs
work lead clamp (grounding clamp)	pince du câble de masse (pince de mise à la terre)

Appendix C
Glossary / Glossaire

arc welding	process that uses an electric arc to produce a molten puddle to join metals	**soudage à l'arc**	procédé dans lequel on utilise un arc électrique pour produire un bain de fusion servant à assembler les métaux
atomized gas	a gas formed when a liquid is dispersed as a stream of droplets	**gaz atomisé**	gaz formé lorsqu'un liquide est dispersé comme un jet de gouttes
backfire	condition in which torch flame rapidly burns back into the torch tip making a pronounced popping sound and causing the gases to rapidly re-ignite; this is usually caused by an excessively dirty torch tip or low gas pressures	**claquement**	condition par laquelle la flamme brûle rapidement de nouveau dans la buse ou la tête du chalumeau, ce qui produit un bruit prononcé de claquement et provoque la réinflammation rapide des gaz; cette condition est généralement causée par une buse ou une tête de chalumeau trop sale ou par de faibles pressions de gaz
barrel	extension for the sub-arc tip; a straight torch	**canon**	rallonge pour la pointe de soudage à l'arc submergé; chalumeau droit
connector (female/male)	used at the end of welding cables or torch hoses to connect cables or hoses together	**raccord (femelle/mâle)**	raccords posés aux extrémités des câbles de soudage ou des tuyaux d'un chalumeau qui servent à joindre les câbles ou les tuyaux
consumables	materials that are consumed in the course of welding and cutting operations	**consommables**	matériaux qui sont consommées au cours du soudage et du coupage

contact tip (contact tube)	tip found at the end of a welding gun in which electricity is transferred from the gun to the consumable wire before the wire enters the weld zone	**tube-contact**	pointe que l'on retrouve au bout du pistolet de soudage dans lequel l'électricité passe du pistolet au fil fusible avant que le fil atteigne la zone de soudure
current type	electrical characteristics including the current (AC, DC) and type (AC, DCEN, DCEP)	**type de courant**	caractéristiques électriques incluant le courant (CA et CC) et le type (CA, courant continu avec électrode négative, courant continu avec électrode positive)
decant	to pour (a liquid) from one container into another	**décanter**	transvider (un liquide) d'un contenant à un autre
drawings	prints (blueprints), assembly drawings, detail drawings, shop and fabrication drawings, hand-drawn sketches, engineered drawings; used to understand types and placement of welds	**dessins**	plans (bleus), dessins d'assemblage, détaillés, d'atelier de de fabrication, schémas dessinés à la main et dessins techniques. Ils sont utilisés pour comprendre le type de soudure et leur position
drive rolls	in wire feed, equipment that comes in various sizes and is used to drive wire through liner to gun contact tip	**galets d'entraînement**	éléments de différentes grandeurs du dévidoir qui servent à guider le fil-électrode à travers la gaine jusqu'au tube-contact du pistolet
dunnage	blocking or cribbing used to support a load	**fardage**	calage utilisé pour soutenir une charge
electrode (rod) ovens	ovens that are maintained at a certain temperature to keep electrodes stabilized and dry	**fours à électrodes (baguettes de soudage)**	fours qui sont maintenus à une température précise pour conserver les électrodes stables et sèches
electrode extension (stick-out)	amount of filler wire, tungsten, or other material protruding from the gun's contact tip or cup of the equipment	**longueur terminale (longueur libre)**	quantité de fil d'apport, de tungstène ou autre matériau sortant du tube-contact du pistolet ou de la coupelle de l'équipement

electrode	a metal core that has a flux coating baked on the outside that is connected with a power source to create an electric arc	**électrode**	fil métallique recouvert d'une couche de flux cuite sur la partie extérieure, connecté à une source d'alimentation pour créer un arc électrique
filler wire	consumable melted during the welding process that becomes part of the weldment	**fil d'apport**	consommable fondu au cours du procédé de soudage qui fait ensuite partie de l'ensemble soudé
flashback arrestor	type of equipment that prevents possible explosions due to ignition of gases in the hoses of oxy-fuel or air/fuel equipment	**dispositif antiretour de flamme**	dispositif qui prévient les explosions que peut provoquer l'allumage des gaz dans les tuyaux flexibles de l'équipement de coupage ou de soudage oxygaz ou aérogaz
flow meter	meter used in conjunction with a regulator to measure the volume of gases used in welding processes	**débitmètre**	instrument utilisé avec un manodétendeur pour mesurer le volume de gaz utilisés au cours du soudage
flux	a material applied before or during joint preparation or surfacing to remove oxides and contaminants	**flux**	matériel appliqué avant ou pendant la préparation d'un joint ou le surfaçage pour enlever les oxydes et les contaminants
gas diffuser	device to distribute shielding gas in a GMAW, FCAW or MCAW process	**diffuseur de gaz**	dispositif qui distribue le gaz de protection pour les procédés GMAW, FCAW et MCAW
gas lens	in gas tungsten arc welding, a collet body holder that diffuses the gas and grips the tungsten	**lentilles à gaz**	dans le procédé de soudage à l'arc sous gaz avec électrode de tungstène, porte-électrode à mandrin qui diffuse le gaz et serre l'électrode de tungstène
guns	part of certain types of welding equipment that is actually held in the hand and is used to control the filler wire	**pistolets**	partie de certains types d'équipement de soudage qui est tenue dans la main et qui est utilisée pour contrôler le fil d'apport

heat treatment	any application of heat to metal assemblies for the purpose of bending, stress relieving, preheating, hardening, or tempering	**traitement thermique**	exposition des assemblages métalliques à la chaleur dans le but de les plier ou de les soumettre à la relaxation des contraintes, au préchauffage, au durcissement ou au revenu
inverter power sources	power sources designed to operate on a high cycle to provide high amperage in a smaller unit	**onduleurs**	sources d'alimentation conçues pour fonctionner à haute fréquence de manière à permettre à un petit appareil de fournir une intensité de courant élevée
magnetic particle examination	test involving magnetic yokes and iron filings to determine the existence of defects or cracks in the surface of the welds	**contrôle magnétoscopique**	essai qui permet de déceler les défauts ou les fissures dans les soudures au moyen d'aimants et de limailles de fer
metallurgy	branch of science that involves the chemical analysis of metals and alloys	**métallurgie**	branche de la science qui comprend l'analyse chimique des métaux et des alliages
modified short-circuit transfer	a controlled short-circuit transfer GMAW process to make single-sided root welds on pipe	**transfert par court-circuit modifié**	transfert par court-circuit contrôlé par procédé GMAW utilisé pour créer une soudure à la racine d'un seul côté d'un tuyau
nozzle	a device that directs shielding media	**buse**	dispositif qui dirige le gaz de protection
pickling paste	acidic compound applied to the surface of stainless steel to replenish the oxide layer, returning the steel to its original condition	**pâte décapante**	composé acide appliqué sur la surface de l'acier inoxydable pour reconstituer la couche d'oxyde, ce qui remet l'acier dans son état d'origine

postheating	heating assemblies after final welds are complete to remove stresses, often involving wrapping the assembly in fire-retardant materials to allow even distribution of heat	**postchauffage**	chauffage des assemblages une fois les soudures finales effectuées pour enlever les contraintes, ce qui nécessite souvent l'enveloppement de l'assemblage dans des produits ignifuges pour permettre une distribution égale de la chaleur
preheating	heating metals to a desired temperature to aid in the welding process	**préchauffage**	chauffage des métaux à une température souhaitée pour faciliter le procédé de soudage
puddle	pool or puddle of molten material that forms the bond between pieces that are being welded	**bain de fusion**	bassin de matière fondue qui constitue la liaison entre les pièces que l'on soude
regulator	piece of equipment that regulates the flow and/or pressure of gases through a hose	**manodétendeur**	appareil qui assure la régulation du débit ou de la pression des gaz dans un tuyau
slag	a nonmetallic product resulting from the mutual dissolution of flux and nonmetallic impurities in some welding and brazing processes	**laitier**	produit non métallique résultant de la dissolution mutuelle du flux et des impuretés non métalliques dans certains procédés de soudage et de brasage
temperature measuring devices	devices used to measure temperature for pre-heat, interpass and post-heat applications	**dispositifs de mesure de la température**	dispositifs utilisés pour mesurer la température de préchauffage, de passe intermédiaire et de postchauffage
transformer rectifiers	type of welding power source that brings in AC power and rectifies it to DC through the use of a diode	**redresseur**	type de source d'alimentation pour le soudage qui redresse le courant alternatif (CA) en courant continu (CC) au moyen d'une diode
work lead clamp	clamp fastened to the end of a welding cable that is then fastened onto a work piece to allow for a completed welding circuit	**pince du câble de masse**	pince fixée au bout d'un câble de soudage qui est lui-même fixé sur la pièce à souder, ce qui complète le circuit de soudage