WEL 801E

Career and Technical Education

Welding Technology

Gas Tungstun Arc Welding

Curriculum Guide

Prince Edward Island
CANADA
Education, Early Learning and Culture

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Career and Technical Education

Curriculum Renewal

Renewal of curriculum begins with the common understanding that K-12 students must engage in learning that enables them to participate in a world of rapid and complex change. This dynamically evolving environment requires that students develop multiple literacies, increase depth of knowledge, and acquire a range of skills, attitudes, and abilities that foster creativity, innovation, and problem-solving skills.

Students must also develop a desire for personal and collective achievement and a willingness to collaborate for the well-being of themselves and others. It is essential that educators and administrators have an in-depth understanding of curricular expectations as part of a broader learning continuum.

Importance of Career and Technical Education

Career and Technical Education (CTE) provides relevance to learning and values the technical skills required to complete meaningful work as equally important to the academic skills required. This blend of thinking and doing is fundamental for CTE students to fully comprehend and demonstrate competency within CTE programming. The false dichotomy between hands-on and heads-on education is no longer relevant to modern education systems or modern economic systems. The current labour market demands that people have the ability to acquire skills, build proficiency, seek out critical knowledge, and adapt to an ever-changing landscape. To this end, students must be lifelong learners who commit to cultivating their knowledge and skills through a combination of experience and education.

High quality Career and Technical Education programs prepare students for success by incorporating rigorous academic and technical skills, essential workplace competencies, and a commitment to career education. Thinking and doing are not at odds; rather each is critical for the development of the other and the success of the learner.

Career and Technical Education curricula are designed to foster the development of all learners as technologically literate and capable citizens who possess the technical skills, strategic knowledge, and agility required in the development of innovative and responsible solutions to relevant technical problems and the career awareness required to transition to further education and work after secondary school.

Goals for Career and Technical Education

Students will develop

- the technical skills, confidence, and employability skills needed to gain employment within their area of interest along with the critical thinking and problem-solving skills required to sustain employment.
- the academic skills required to further their education and to embrace the ever-changing reality of technical work as active learners and innovators with an entrepreneurial spirit.
- the knowledge, skills, and attitudes that will enable the agility required to be actively engaged in the development and implementation of their own career plans.

> "If, instead of keeping a child at his books, I keep him busy in a workshop, his hands labor to his mind's advantage: while he regards himself only as a workman he is growing into a philosopher."
>
> Jean Jacques Rousseau
> Emile; or, Concerning Education
> p. 140, 1889.

Course Descriptions

WEL701A - Shielded Metal Arc Welding Level I (prerequisite for all 800 level CTE-Welding courses)

The SMAW Level I course is the entry level course to Welding Technology. Students will be introduced to tools, equipment, theories, and practices that are common to the trade with a constant emphasis on safe work habits. Students will develop attention and concentration skills that will allow them to minimize the hazards associated with welding. The course will focus on the SMAW process to establish a basic foundation of welding skills. Students may also experience other welding processes as determined by the course projects.

WEL801A - Shielded Metal Arc Welding Level II (WEL 701A required)

Welders always strive to achieve a high standard of quality in their work. During this course, students will learn about the various types of weld joints and to select the proper electrodes for various SMAW tasks. Students will learn to diagnose and correct problems that arise when using SMAW equipment, identify and safely use power tools common to the trade, and develop the theoretical and practical skills required to perform high quality SMAW welds in all positions.

WEL801B - Gas Metal Arc Welding Level I (prerequisite for WEL801C)

Gas metal arc welding (GMAW) is extensively used in industry. During this course, students will learn to identify, describe, and safely use the equipment and tools required to perform GMAW welds. They will select the proper GMAW filler metals and shielding gases, and correctly identify and select proper weld joints required to complete projects.

WEL801C - Gas Metal Arc Welding Level II (WEL701A and WEL801B required)

The GMAW Level II course will focus on students building proficiency and accuracy within the skill of GMAW welding. Industry demands and sets a high standard for welders, and students are expected to develop the physical hand skills required to perform GMAW welds in all positions. This will include maintaining and adjusting equipment, power sources, and consumables to ensure quality welds.

WEL801D - Flux Core Arc Welding

Flux core arc welding is recognized as a high production process for welded fabrication projects. During this course, students will learn to select and safely use the correct FCAW equipment, shielding gases, and filler metals, and perform FCAW welds in all positions. They will also combine the GMAW and FCAW welding processes.

WEL801E Gas Tungstun Arc Welding

Gas tungsten arc welding is a precise method of welding various types of metal. GTAW is a welding process widely used in the welding fabrication industry. During this course, students will learn to identify, describe, and safely use the equipment and tools required to perform GTAW welds in a variety of positions on various types of metal.

Students wanting to challenge the Level 1 Apprenticeship Exam for Welder will require a minimum of 5 CTE-Welding courses. The students average in all courses must be at or above 70% to qualify to challenge the Apprenticeship Exam.

Essential Graduation Competencies (EGCs)

EGC Overview

Curriculum is designed to articulate what students are expected to know and be able to do by the time they graduate from high school. The PEI Department of Education, Early Learning and Culture designs curriculum that is based on the Atlantic Canada Framework for Essential Graduation Competencies released by the Council of Atlantic Ministers of Education and Training (CAMET) in 2015.

Competencies articulate the interrelated sets of attitudes, skills, and knowledge—beyond foundational literacy and numeracy—that prepare learners to successfully participate in lifelong learning and life/work transitions. They are cross-curricular in nature and provide opportunities for interdisciplinary learning. Six competencies have been identified by CAMET: citizenship, communication, personal-career development, creativity and innovation, critical thinking, and technological fluency (Figure 1). Achievement of the essential graduation competencies (EGCs) will be addressed through the assessment and evaluation of curriculum outcomes developed for individual courses and programs.

EGC Definitions

Critical Thinking

Learners are expected to analyse and evaluate evidence, arguments, and ideas using various types of reasoning and systems thinking to inquire, make decisions, and solve problems. They reflect critically on thinking processes.

Technological Fluency

Learners are expected to use and apply technology to collaborate, communicate, create, innovate, learn, and solve problems. They use technology in a legal, safe, and ethically responsible manner.

Citizenship

Learners are expected to contribute to the quality and sustainability of their environment, communities, and society. They analyse cultural, economic, environmental, and social issues; make decisions and judgments; and solve problems and act as stewards in a local, national, and global context.

Communication

Learners are expected to express themselves and interpret effectively through a variety of media. They participate in critical dialogue, listen, read, view, and create for information, enrichment, and enjoyment.

Personal-Career Development

Learners are expected to become self-aware and self-directed individuals who set and pursue goals. They understand and appreciate how culture contributes to work and personal life roles. They make thoughtful decisions regarding health and wellness, and career pathways.

Creativity and Innovation

Learners are expected to demonstrate openness to new experiences; to engage in creative processes; to make unexpected connections; and to generate new and dynamic ideas, techniques, and products. They value aesthetic expression and appreciate the creative and innovative work of others.

Curriculum Design

General Curriculum Outcomes (GCOs)

General curriculum outcome statements articulate what students are expected to know and be able to do upon completion of study in technology education. These statements provide a concise description of the student as a technologically literate and capable citizen.

Technological Problem Solving

Students will be expected to design, develop, evaluate, and articulate technological solutions.

Technological problem solving incorporates a variety of strategies and processes, consumes resources, and results in products and services. Technological problem solving constitutes one of the most important ways in which students engage in technological activity.

Technological Systems

Students will be expected to operate and manage technological systems.

Technological systems are the primary organizational structure for products and services. Understanding the nature of systems and understanding how to employ, moderate, and re-structure systems are important components of technological literacy and capability.

History and Evolution of Technology

Students will be expected to demonstrate an understanding of the history and evolution of technology, and its social and cultural implications.

Technology, like many other areas of human endeavour, is often best understood in its historical context. Technology has had and continues to have profound effects on individuals, society, and the environment. Understanding the origins and effects of a particular technology provides a context for resolving today's problems and issues, and often leads to better solutions.

Technology and Careers

Students will be expected to demonstrate an understanding of current and evolving careers and the influence of technology on the nature of work.

All jobs, occupations, careers, and professions exist in technological environments. An understanding of the range of technologies in the workplace and their effects on the nature of work is critical to planning career and education paths.

Technological Responsibility

Students will be expected to demonstrate an understanding of the consequences of their technological choices.

The development of technology, and by extension its impact in the future, is entirely under human control. Individually and collectively, we share that responsibility. Accepting the responsibility and being empowered to take appropriate action require technological literacy and technological capability (knowledge, skills, and willingness).

Specific Curriculum Outcomes (SCOs)

Specific curriculum outcomes state the intended outcomes of instruction, and identify what students are expected to know and be able to do for a particular unit or course. SCOs provide the goals or targets of the prescribed education program referenced in 71(a) of the PEI Education Act. They provide a focus for instruction in terms of measurable or observable student performance and are the basis for the assessment of student achievement across the province. PEI specific curriculum outcomes are developed with consideration of Bloom's Taxonomy of Learning and essential graduation competencies.

Specific curriculum outcomes will begin with the phrase, "Students are expected to…".

Achievement Indicators (AIs)

Each specific curriculum outcome is described by a set of achievement indicators which help to support and define the depth and breadth of the corresponding SCO when taken as a set.

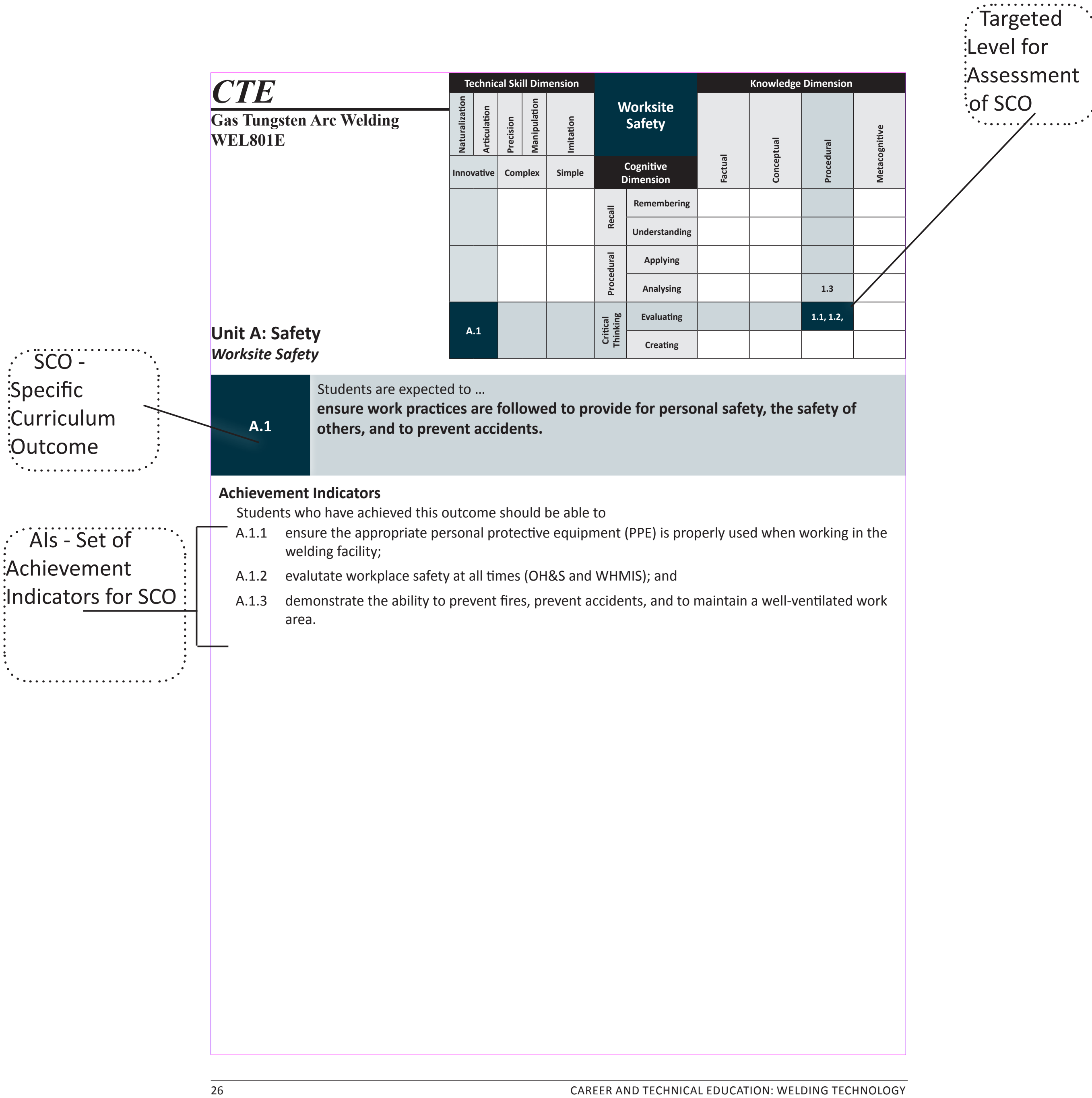
The set of achievement indicators provided for an SCO

- provides the intent (depth and breadth) of the outcome;
- tells the story, or creates a picture, of the outcome;
- defines the level and types of knowledge intended by the outcome;
- is not a mandatory checklist, prioritized list of instructional activities, or prescribed assessment items; and
- may include performance indicators.

The intent of AIs is for clarity and understanding, so that instructional design is aligned with the SCO. When teachers are planning for instruction, they must be aware of the set of indicators in order to fully understand the depth and breadth of the outcome. Teachers may substitute or add to the set of AIs as long as these additions maintain the integrity of the SCO. By constantly analysing and monitoring the needs of the students, teachers can determine which indicators are appropriate and relevant to prior knowledge, developmental stages, or the continuum of the scholastic year.

Lists of achievement indicators will begin with the phrase, "Students who have achieved this outcome should be able to…".

Sample of Curriculum Page



CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension					Worksite Safety		Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension					
					Recall	Remembering				
						Understanding				
					Procedural	Applying				
						Analysing			1.3	
A.1					Critical Thinking	Evaluating			1.1, 1.2,	
						Creating				

Unit A: Safety
Worksite Safety

A.1

Students are expected to ...
ensure work practices are followed to provide for personal safety, the safety of others, and to prevent accidents.

Achievement Indicators

Students who have achieved this outcome should be able to

A.1.1 ensure the appropriate personal protective equipment (PPE) is properly used when working in the welding facility;

A.1.2 evalutate workplace safety at all times (OH&S and WHMIS); and

A.1.3 demonstrate the ability to prevent fires, prevent accidents, and to maintain a well-ventilated work area.

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Elaborations

An elaboration provides a fuller description of the SCO and the instructional intent behind it. It sets the parameters of the SCO, gives background information where possible, and offers a broader context to help teachers gain a deeper understanding of the scope of the SCO. This may also include suggestions and/or supporting resources that may be helpful in teaching the related outcome. Teachers should vet material for any inappropriate sidebars, questionable information, or redirected links.

Performance Indicators

Performance indicators are located in the Elaboration section of the guide. They are intended to provide the teacher with a wide range of activities, ideas, and/or tasks that students may be engaged with as they progress towards mastery of an outcome. Performance indicators are not prescriptive and are not a checklist. The list of performance indicators is by no means an exhaustive list of possible tasks a student may engage in as they are working towards the outcome. Performance indicators help teachers to connect the work the students are engaged in to particular outcomes within a course.

Formative Assessment Guide

The formative assessment guide provides teachers with a general description of what the students are able to do within the context of each unit at each level of technical skill development. Teachers can use this tool as a foundation when developing customized rubrics, checklists, or observation methods. Teachers can also use the language in the formative assessment guide when providing descriptive feedback to students on how well they are progressing towards the learning outcome.

National Occupational Analysis

Each elaboration will also contain a reference to the National Occupational Analysis (NOA), for the trade. This is provided to highlight which Tasks, Required Knowledge, and Sub-tasks are aligned to a particular set of outcomes. Teachers are encouraged to familiarize themselves with the NOA for their trade. The NOA is designed to facilitate understanding of the occupation and the work performed by tradespersons.

Bloom's Taxonomy

In 1956, Bloom, et.al., published a framework for the purpose of classifying expectations for student learning as indicated by educational outcomes. This unidimensional framework of cognitive processes became known as Bloom's Taxonomy. David Krathwohl's 2002 revision of this taxonomy introduced a second dimension, the knowledge dimension, that classified the type of knowledge described by an outcome. To fully understand a specific curriculum outcome, it is important to understand how the learning is representative of both the cognitive process and knowledge dimensions.

Knowledge Process Dimension

The knowledge process dimension classifies four types of knowledge, ranging from concrete to abstract, learners may be expected to acquire or construct. The noun included in a specific curriculum outcome represents the knowledge process dimension.

	Explanation of Knowledge Level
Factual The basic elements students must know to be acquainted with a discipline or solve problems in it **KNOWING THAT**	• knowledge of terminology (e.g., technical vocabulary, name of equipment) • knowledge of specific details and elements (e.g., general shop safety procedures, operating procedures)
Conceptual The interrelationship among the basic elements within a larger structure that enables them to function together **KNOWING WHAT and WHY**	• knowledge of classifications and categories (e.g., types of tools, equipment, and materials) • knowledge of theories, models, and structures (e.g., metallurgy, heat transfer)
Procedural How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods **KNOWING HOW**	• knowledge of subject-specific-skills and algorithms (e.g., technical skills with tools, weld procedures) • knowledge of subject-specific techniques and methods (e.g., safe operating procedures for welding equipment) • knowledge of criteria for determining when to use appropriate procedures (e.g., work orders, welding symbols)
Metacognitive Knowledge of cognition in general as well as awareness and knowledge of one's own cognition **KNOWING HOW TO KNOW**	• strategic knowledge (i.e., knowledge of where to locate required information) • knowledge about cognitive tasks, including appropriate contextual and conditional knowledge (i.e., knowledge of the skills required to complete a task) • Self-knowledge (i.e., awareness of one's own knowledge and ability level)

Cognitive Process Dimension

The cognitive process dimension represents a continuum of increasing cognitive complexity, from lower order thinking skills to higher order thinking skills. The verb that begins a specific curriculum outcome represents the cognitive process dimension. The verbs listed under each cognitive process dimension represent the specific verbs used for SCOs or AIs within all six welding curricula. There is also a subject-specific definition of each cognitive process dimension that relates directly to welding technology.

Explanation of Cognitive Process Dimension	
Remembering	Retrieve, recall, and/or recognize specific information or knowledge from memory
define, follow, locate	Students define terminology and locate equipment, tools, and safety requirements. Students follow protocols and procedures established within the welding facility.
Understanding	Construct meaning from different sources and types of information, and explain ideas and concepts
choose, describe, discuss, explain, identify	Students can describe and/or explain the function and operation of welding equipment and procedures by reading, writing, and speaking. Students choose the correct procedure, tool, or resource to support their understanding of the knowledge and skill required to meet the outcome.
Applying	Implement or apply information to complete a task, carry out a procedure through executing or implementing knowledge
apply, determine, draw, maintain, practise, read, share, use, write	Students execute a given task or work order when the procedure is provided. Students deepen their understanding of concepts by engaging their hands and practising their skills. Students communicate both orally and in writing, and are able to access information related to the welding process they are engaged in.
Analysing	Break information into component parts and determine how the parts relate or interrelate to one another or to an overall structure or purpose
compare, demonstrate, inspect	Students make the connection between the theory and the practice. Students begin to put together their understanding of welding parameters, faults, and defects with their ability to complete tasks. Students will start to make connections between tasks and begin to transfer their knowledge to new situations. For example, when a student is demonstrating a weld in a required position they should be able to clearly demonstrate an understanding of both the theory and skills required to successfully complete the task.
Evaluating	Justify a decision or course of action, problem solve, or select materials and/or methods based on criteria and standards through checking and critiquing
enhance, ensure, evaluate, interpret, perform, reflect, select	Students make decisions and select and adjust the working parameters independently to complete welding tasks. Students begin to respond to challenges and perform tasks with a combination of both skill and precision. For example, when a student is performing a task they will interpret information and troubleshoot problems as they arise. Students will reflect on jobs and critique their own, and others performance.
Creating	Form a coherent functional whole by skillfully combining elements together and generating new knowledge to guide the execution of the work
construct, create, design, develop, repair	Students can construct weld projects and develop solutions to welding repair problems safely, efficiently, and precisely. Students begin to take responsibility for their own knowledge and skill as a welder, approach their work in an independent manner, and with a proficiency of skill.

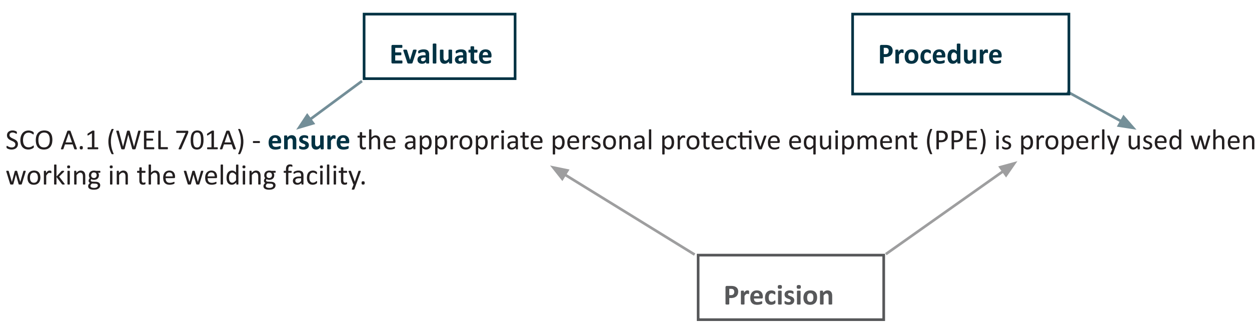
Technical Skill Dimension

The technical skill dimension, as defined by Dave's psychomotor taxonomy (1975), classifies five types of ways learners may be expected to demonstrate or carry out skilled tasks, procedures, or movements. This ranges from imitation, (where students mimic what they see modelled), through to naturalization, (where students perform tasks automatically and with high level of skill).

Explanation of Technical Skill Dimension	
Imitation	ability to copy or replicate the actions of others following observations
Manipulation	ability to repeat or reproduce actions to prescribed standard from memory or instructions
Precision	ability to perform actions with expertise and without interventions and the ability to demonstrate and explain actions to others
Articulation	ability to adapt existing psychomotor skills in a non-standard way, in different contexts, using alternative tools and instruments to satisfy need
Naturalization	ability to perform actions in an automatic, intuitive, or unconscious way appropriate to the context

SCO Structure

Examining the structure of a specific curriculum outcome is necessary to fully understand its intent prior to planning instruction and assessment. The Bloom's verb in the outcome relates to the expected level and type of thinking (cognitive process). A noun or phrase communicates the type of knowledge (i.e., factual, conceptual, procedural, or metacognitive) that is the focus of the outcome. The degree of technical skill is communicated through the remainder of the outcome and indicated on the Taxonomy Table.



Taxonomy Tables

Combining the three dimensions, (cognitive process dimension, knowledge process dimension, and technical skill dimension), into one taxonomy table helps teachers to visualize the overall expectations of a course. As teachers reflect deeply and collaborate with each other to identify the types of knowledge required by each outcome, they will be better able to plan what student achievement will look, sound, and feel like in the learning environment. This clear visualization of the desired results (i.e., evidence of achievement of outcomes) assists teachers in planning learning experiences that will lead to student achievement of the outcome at the targeted level.

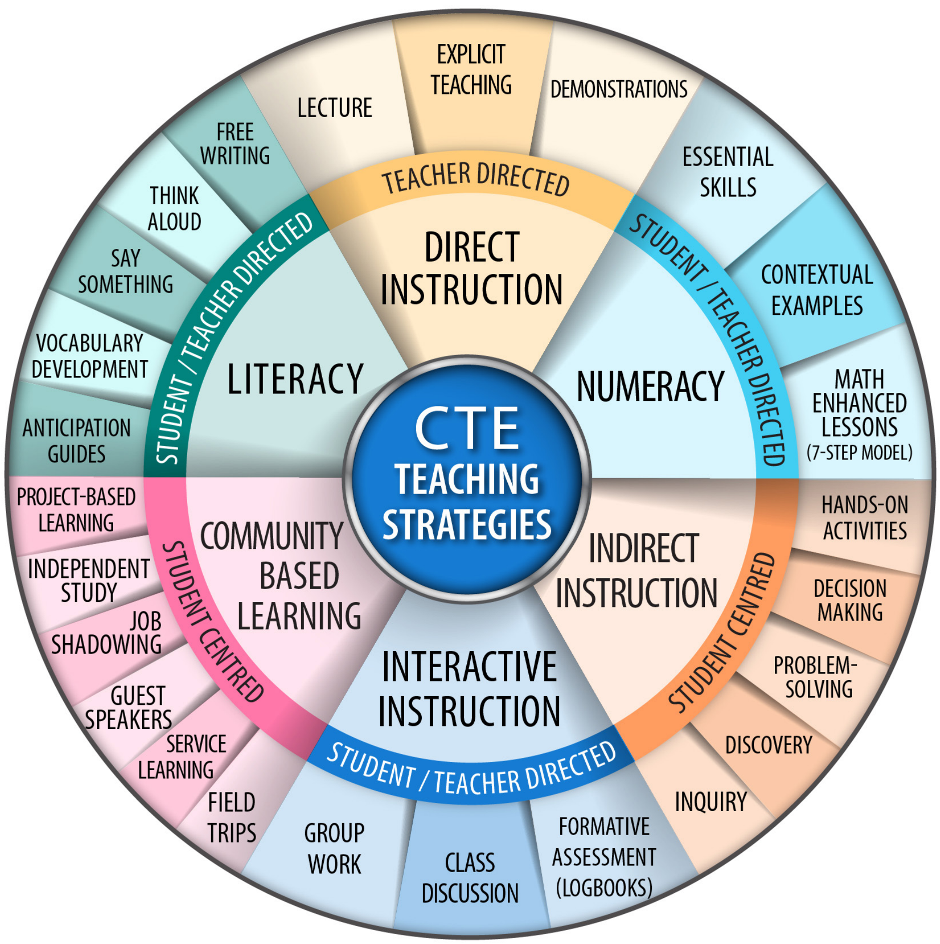
The taxonomy table for WEL 801E appears on page 25. Each outcome also has a taxonomy table that is specific to that outcome and the given achievement indicators. The table is located on the upper right-hand corner.

Curriculum Delivery

Instructional Strategies

Teaching is both a science and an art. There is a wealth of instructional strategies and methodologies described in the literature related to career and technical education that teachers have at their disposal when creating a learning environment that best suits the needs of their students.

Below is an instructional strategies wheel that is designed to identify a range of strategies that are effective when preparing lessons, assignments, and experiences for the career and technical education classroom. The list is not intended to be exhaustive, and CTE teachers are encouraged to continually read and engage in current research, pedagogy, and practice related to their field.



Literacy

Employing cross-curricular reading and writing strategies in the delivery of the curriculum will provide students with tools that will help them build knowledge and develop strategies to become more proficient in both their technical skills and their literacy skills. Integrating literacy into the CTE classroom is essential for students to develop strong connections between the practical skills and technical knowledge required.

Pre-Reading Strategies

Pre-reading strategies are used prior to assigning a reading and are designed to activate the students' prior knowledge on a subject, promote inquiry and discussion, provide clarity, and give the students reason to engage in the text. Examples include the following:

- FREE WRITING - This strategy provides students with a short amount of time to record what they already know or believe about the topic. Free writes should never be collected or evaluated. The only rule of the free write is that students write for the entire time allotted even if they run out of things to say.
- ANTICIPATION GUIDES - These guides consist of four or five statements about a topic that students are asked to either agree or disagree with prior to reading. The statements should be carefully crafted to raise the students' interest in the subject (so that all students do not respond in the same way), and be supported by the assigned reading. After reading, students should revisit and discuss their responses.

During-Reading Strategies

During-reading strategies are designed to promote active reading of the material. They provide students with specific tasks to complete or things to discover while reading the document. During-reading strategies can be used in small groups or as individual tasks.

- *THINK ALOUD* - Think Aloud is a very effective strategy to use when reading aloud to students. During the Think Aloud, it is important to model and reflect on how you yourself make meaning when reading challenging trade-related text, and how you relate the topic back to prior topics covered.
- *SAY SOMETHING* - Before assigning the Say Something, take time to model the strategy with a student or colleague and review the rules that will make for a successful Say Something. It is a good idea to post these rules so everyone can see them and be reminded of them during the activity.
    - *With your partner, decide who will say something first.*
    - *When you say something, make a prediction, ask a question, clarify something you had misunderstood, and/or make a connection.*
    - *If you cannot do one or more of the above things, then you need to re-read.*
- *RE-READING* - "Re-reading is probably the number one strategy independent readers use when something stumps them in a text. It's probably the last strategy dependent readers use" (Beers 2003, p.105). Before asking students to re-read a section of text, you must first set the activity up for success.
    - *Prove to students that re-reading is valuable to their learning. You can model this while doing a Think Aloud where you model your thinking as you interpret the text.*
    - *Provide the students with specific tasks to complete while they re-read a section.*
    - *Review the text as a group after everyone has re-read it.*

Post-Reading Strategies

Post-reading strategies are designed to provide students with opportunities to reflect on what they have read and make links to their learning.

- *LEARNING JOURNALS* - These journals provide a forum through which students can record and document their learning.
- *SUMMARIZING* - Summarizing is an effective strategy to use prior to having students complete an assigned task in the shop. This provides students with an opportunity to describe what they are going to do and how they plan to accomplish it. This may be done in written form or orally, depending on the given task.

Math in CTE

The National Council of Teachers of Mathematics states that wanting all students to learn math does not mean that all students can or should learn math in the same way.

The National Research Center for Career and Technical Education (NRCCTE) has developed the Math in CTE model that addresses and makes explicit the math concepts as they arise naturally from the CTE curriculum. Math is an essential component of CTE curriculum and is an essential tool required to perform the tasks of given occupations (NRCCTE 2006).

One of the challenges in teaching contextual math in CTE is that students are unable to transfer the math skills and knowledge to a new situation, as it is too embedded in the original context (NRCCTE 2006). The Math in CTE model addresses this challenge by bringing the math skill out of context and into the abstract, so that students may develop the understanding behind what they are learning, and then the model continues to provide opportunities for students to apply the knowledge in context.

By making explicit the math that is incorporated into the CTE context, students are able to make connections to their math classes and develop their transferable math skills.

Math in CTE 7-Step Model

Below is the 7-step Math in CTE model that will enable CTE teachers to identify the math skills covered in their lessons, develop a math-enhanced lesson, and assess the students' math abilities.

Introduce technical lesson.

- Explain the technical lesson.
- Identify the math embedded in the lesson.

Assess students' math awareness.

- Use a formative assessment.
- Assess whether students use the correct mathematical terms when discussing the lesson topic.
- Use a variety of questioning/discussion techniques to determine students' math awareness.

Work through math problems related to the technical lesson.

- Connect the technical vocabulary to the math vocabulary and gradually integrate the two, being sure to not abandon either set.

Work through related contextual examples.

- Use examples with varying levels of difficulty.
- Continue to bridge the gap between the technical concept and the math skills.
- Check for understanding.

Work through traditional math examples.

- Provide students with an opportunity to practise using a worksheet of basic math problems as they would appear on a test.
- Move from basic to advanced examples.
- Check for understanding.

Have students demonstrate understanding.

- Provide students with the opportunity to relate the math concept back to CTE context.
- Conclude the math lesson back in the context of the technical lesson.

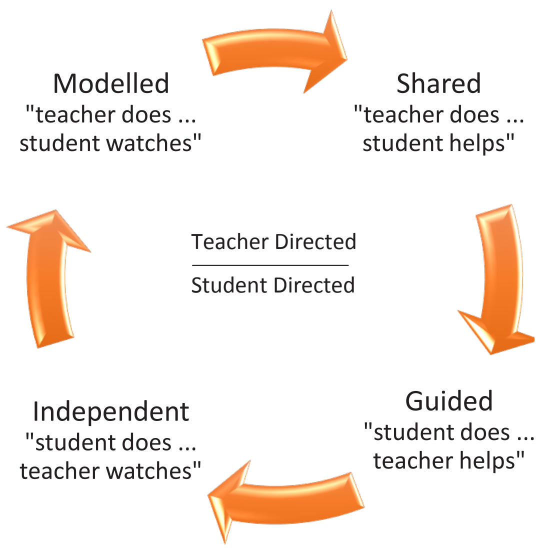
Assign a formal assessment.

- Include math problems in formal assessments of the technical lesson.

Gradual Release of Responsibility

Teachers must determine when students can work independently and when they require assistance. In the *gradual release of responsibility* approach, students move from a high level of teacher support to independent practice. The teacher models a concept or strategy and makes explicit the thinking he/she engages in when choosing and applying the strategy in a specific context. The teacher gradually releases the responsibility through a phase of shared and guided practice that leads the student to independence. If necessary, the teacher increases the level of support when students need further assistance. Gradual release is a useful strategy to employ. The graphic below provides a visual representation of this process.

Teachers may wish to begin the process at any point in the cycle. For example, teachers may provide a diagnostic assessment (independent stage) to establish what students know prior to teaching in order to determine which practices need to be modelled and which ones the students are able to perform independently.



Curricular Planning Using Understanding by Design

Understanding by Design (UbD) is often referred to as backward design. UbD is a curricular planning model developed by American educators Grant Wiggins and Jay McTighe. The main premise is that learning, and hence understanding, must be demonstrated through *transference*—the ability to apply what has been learned to a new situation or problem. In order to assess the level of learning, it is necessary to plan instruction as a backward experience of three stages beginning with the *end-in-mind* or the desired results, moving to the second stage of *evidence-of-learning* or assessment, and ending with the *learning plan* or the activities that will engage students and scaffold them toward the end result or *performance task*.

Basics of UbD

- helps transform specific curriculum outcomes (SCOs) into meaningful learning elements and assessments
- encourages teachers to become coaches and facilitators of meaningful learning rather than purveyors of superficial content
- reveals learning when students make sense of, and are able to transfer, learning to new and authentic situations
- requires ongoing review of instructional design to ensure effective practice and continuous improvement for achievement
- promotes a way of thinking about curricular planning in a broader sense, not a rigid program or prescriptive plan
- ensures deeper student understanding by making meaning from big ideas
- overcomes instructional errors associated with simplified textbook coverage and activity-oriented teaching (activity without a clear purpose)

Stage 1 Desired Results	Stage 2 Evidence	Stage 3 Learning Plan
The knowledge, skills, and attitudes that are articulated in specific curriculum outcomes (SCOs) are identified.	Performance tasks and criteria are determined. *Performance tasks* should be authentic tasks that are designed to simulate or replicate real-world performances and establish a realistic context with a genuine purpose, audience, and constraints. *Performance criteria* will provide the evidence of learning that is needed to assess the learning. Criteria can be weighted and include the following: • **Content** - aptness, adequacy, or accuracy of knowledge and skills used • **Process** - the means, processes, attitude, or approaches taken in the performance or in the preparation for performance • **Quality** - attention to detail, polish, and craftsmanship • **Impact** - Did the performance work? What was its effect, its result, its outcome - irrespective of effort, attitude, and approach?	In the final stage, the sequence of learning activities that will scaffold students toward the performance task and understanding are planned.

The Evaluative Process

Through the entire evaluative process, the teacher reflects on the appropriateness of the assessment techniques used to evaluate student achievement of the SCOs. Such reflection assists the teacher in making decisions concerning adjustments to subsequent instruction, assessment, and evaluation.

Assessment and evaluation are integral components of the teaching and learning processes.

Effectively planned evaluation promotes learning, builds confidence, and develops students' understanding of themselves as learners. Effectively planned assessment and evaluation also improves and guides future instruction and learning.

Effective and authentic assessment involves

- designing performance tasks that align with specific curriculum outcomes;
- including students in determining how their learning will be demonstrated; and
- planning for the three phases of assessment (*for*, *as*, and *of* learning).

Assessments need to be reflective of the cognitive process(es) and level(s) of knowledge and skill indicated by the outcome. An authentic assessment will collect data at the level for which it is designed.

Whether conducting assessment for learning or assessment of learning, a teacher must have sufficient proof of a student's learning. By using a process known as triangulation, teachers can obtain data of student learning from three different sources, (i.e., observations, conversations, and products), thereby ensuring sufficient data is collected in order to evaluate student learning. Observations and conservations are more informal forms of evidence that may be, for example, recorded as anecdotal notes. Products include tests, projects, or other tasks that enable students to demonstrate what they know and can do at the end of the learning process. By collecting data from multiple sources, teachers are able to verify the data they collect against each other, thus allowing them to gain an accurate portrayal of student progress.

Effective evaluation involves considering the totality of the assessment data and interpreting it to make informed judgments about student learning.

Assessment

Assessment is the act of gathering information on an ongoing basis in order to understand students' individual learning and needs. It is the journey of their learning.

Effective assessment improves the quality of learning and teaching. It helps students to become self-reflective and to feel in control of their own learning, and enables teachers to reflect on and adjust their instructional practices. When students are given opportunities to demonstrate what they know and what they can do with that knowledge, optimal performance can be realized.

Assessment has three interrelated purposes:

- assessment *for* learning to guide and inform instruction
- assessment *as* learning to involve students in self-assessment and setting goals for their own learning
- assessment *of* learning to determine student progress relative to curriculum outcomes

Even though each of the three purposes of assessment requires a different role and planning for teachers, the information gathered through any one purpose is beneficial and contributes to an overall picture of an individual student's achievement.

All assessment practices should respect the needs of diverse learners and should respect and appreciate learners' cultural diversity. Teachers should provide students with a variety of ways to demonstrate on an ongoing basis what they know and are able to do with many different types of assessment over time. Valuable information about students can be gained through intentional conversations, observations, processes, performance, and products. A balance among these sources ensures reliable and valid assessment of student learning.

Effective assessment strategies

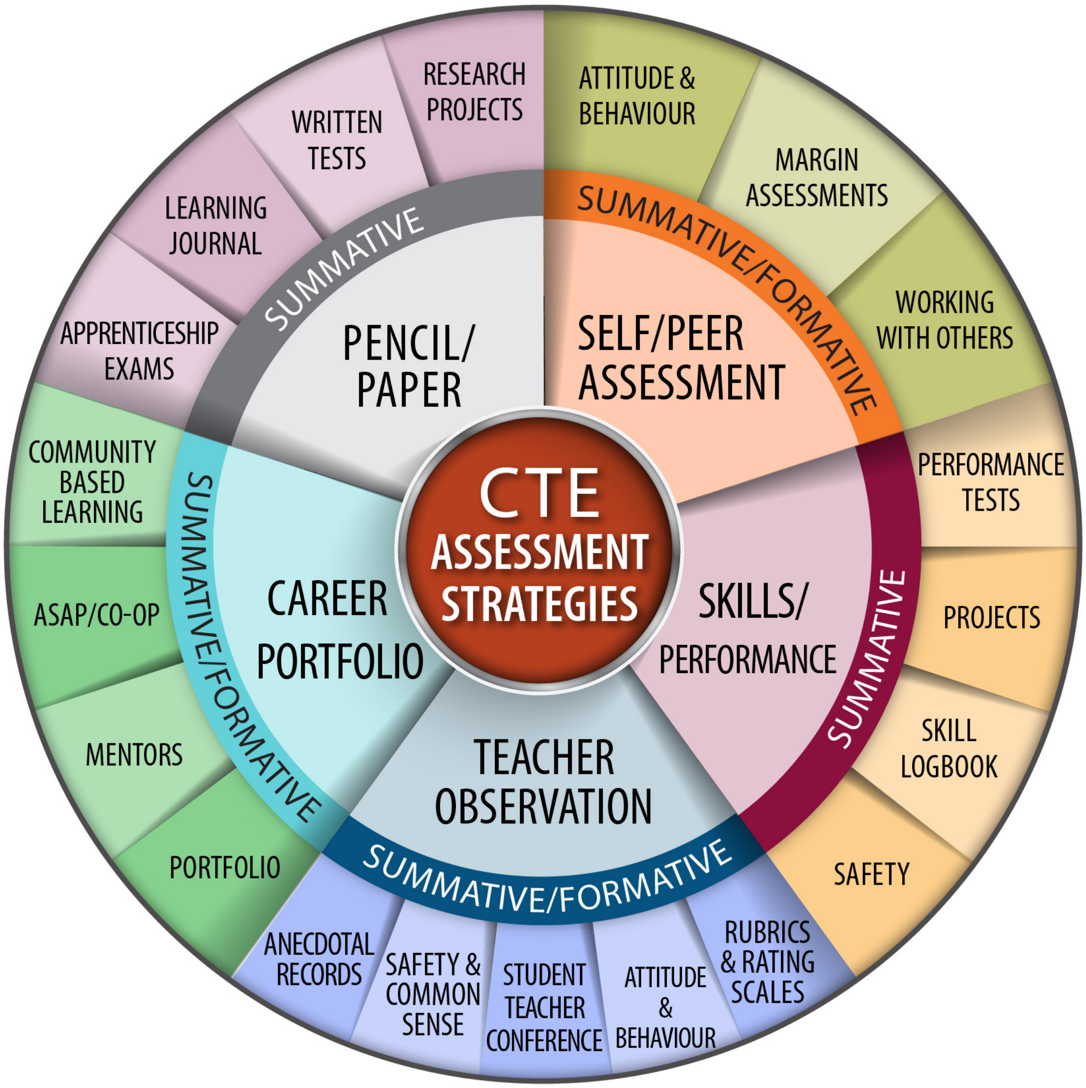
- are appropriate for the purposes of instruction, the needs and experiences of the students, and learning strategies used;
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility;
- reflect where the students are in terms of learning and help to determine the levels and types of support or instruction that will follow;
- allow for relevant, descriptive, and supportive feedback that gives students clear directions for improvement, and engages students in metacognitive self-assessment and goal setting that can increase their success as learners;
- are explicit and communicated to students and parents so students know expectations and criteria to be used to determine the level of achievement;
- must be valid in that they measure what they intend to measure and reliable in that they consistently achieve the same results when used again, or similar results with a similar group of students;
- involve students in the co-construction, interpretation, and reporting of assessments by incorporating their interests, multiple intelligences, and learning styles;
- accommodate for the diverse learning needs of students; and
- are comprehensive and enable all students to have diverse and multiple opportunities to demonstrate their learning consistently and independently.

Students should know what they are expected to learn as designated by SCOs and the criteria that will be used to determine the quality of their achievement.

This information allows students to make informed choices about the most effective ways to demonstrate what they know and are able to do. It is important that students participate actively in assessment by co-creating criteria that can be used to make judgments about their own learning. Assessment must provide opportunities for students to reflect on their progress, evaluate their learning, and set goals for future learning. Students may benefit from examining various scoring criteria, rubrics, and student exemplars.

Student involvement in the assessment process can be achieved by

- incorporating students' interests into assessment tasks (e.g., allowing students to select and read texts that relate to their interests);
- providing opportunities for students to self-assess their learning; and
- co-creating assessment criteria with the student, working to describe how a specific skill or product is judged to be successful; and using student exemplars to illustrate a range of skill development (i.e., practise using the assessment criteria to guide their own work).



Evaluation

Evaluation is the culminating act of interpreting the balanced information gathered through relevant and authentic assessments for the purpose of making judgments.

Inherent in the idea of evaluating is “value.” **Evaluation is based on the cumulative assessments of the SCOs. The SCOs should be clearly understood by learners before instruction, assessment, and evaluation takes place.** Evaluation is informed by a quality, authentic formative and summative assessment process.

During evaluation, the teacher:

- interprets all assessment information and makes judgments about student progress;
- reports on student progress; and
- makes informed decisions about student learning programs based on the judgments or evaluations.

STEAM Pedagogy

The acronym STEAM represents Science, Technology, Engineering, Art, and Math. STEAM education is a pedagogical approach which provides students the opportunity to integrate learning associated with these five disciplines while solving meaningful problems.

The original acronym, STEM was introduced in the 1990s by the National Science Foundation. The 'A' was added to STEM in recognition that creative thinking normally associated with art is as necessary as analytical thinking when solving problems in science, engineering, and technology. The ability to think mathematically is also an integral aspect of these three fields.

Problem solving is an iterative, multi-layered and multi-stepped process that requires flexible thinking patterns (Figure 12). The analytical thinking component involves selecting, gathering, sorting, comparing, and contrasting information. Analytical thinking is convergent thinking which helps to identify and narrow possible solutions. Creative thinking is required to solve broad, open-ended problems that do not have a readily apparent solution and are not single-outcome specific. Creative processes involves divergent thinking or out-of-the-box thinking. A creative thinker may consider solutions that are based on intuition and emotion rather than logic. Creative solutions can also arise from observation, inspiration, and serendipity. STEAM activities are designed to encourage the flexibility to move back and forth between these two cognitive processes. They also support the development of other habits of mind necessary for STEAM such as persistence and resilience.

Selected Habits of Mind and Skills Encouraged by STEAM

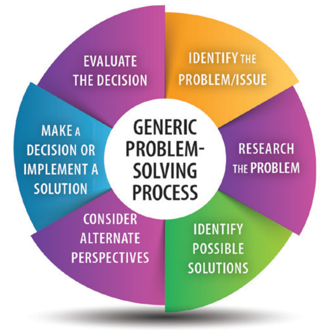
- creativity
- innovation
- persistence
- resilience
- flexibility
- collaboration
- communication
- critical thinking
- analytical thinking
- manipulative skills
- digital fluency

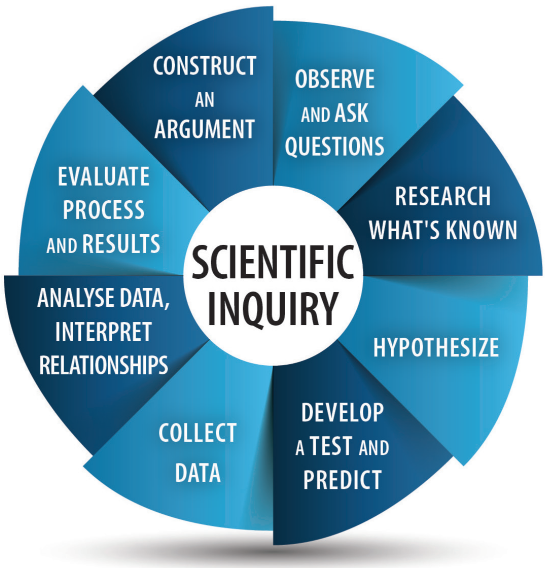
All five disciplines do not have to be targeted at the same time during a STEAM activity. To obtain the benefit of STEAM-based instruction, the problem presented should not have a readily apparent solution or be single outcome specific. The problem should be open-ended and designed in a way that the learner has more than one possible path to the solution. Productive struggle and reflection should be encouraged.

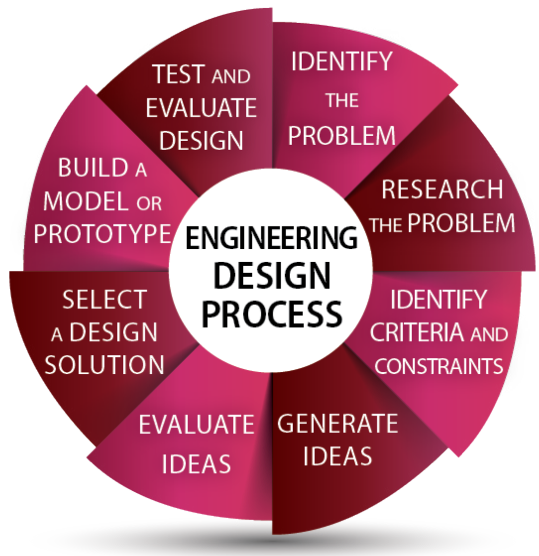
Problem-Solving Component	**S**	**T**	**E**	**A**	**M**
	Science	Technology	Engineering	Art	Mathematics
Nature of Problem	Extending our understanding of the natural world	Developing ways to extend human capacity	Addressing a human need or concern	Expressing and interpreting human perception	Discovering mathematical relationships
Name of Process	Scientific Inquiry	Technology Design	Engineering Design	Creative Process	Mathematical Analysis
Initial Question	What causes...?	How can I...?	How can I make...?	Imagine if...	What is the relationship...?
Solutions and Products	Communications of new knowledge	Digital products, digital processes	Structures, equipment, machines, processes	Aesthetic expression, products, processes	Numerical solutions, equations

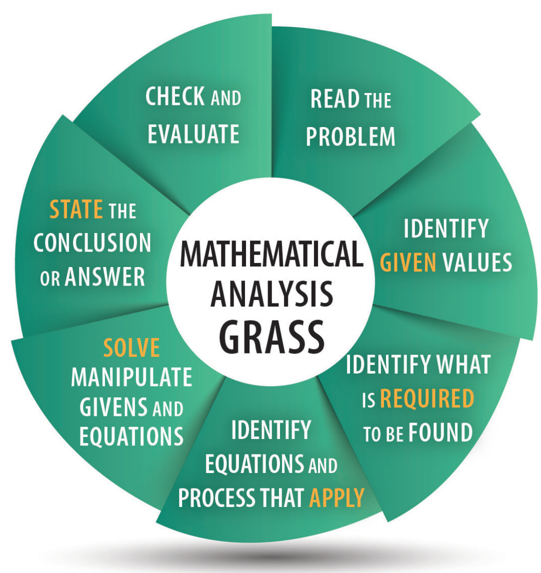
Steam Processes

STEAM problem-solving processes (i.e., scientific inquiry, technology and engineering design, the creative process, and mathematical analysis) differ in the nature of the question and the solution or product. However, all are based on the generic problem-solving process. All are iterative processes that involve reflection, evaluation, and feedback throughout. All require analytical thinking and creative thinking. The figures below compare the problem-solving processes for science, engineering, art, and math.









Career & Technical Education

Welding Technology

Gas Tungstun Arc Welding

Course Description

Gas tungsten arc welding is a precise method of welding various types of metal. GTAW is a welding process widely used in the welding fabrication industry. During this course, students will learn to identify, describe, and safely use the equipment and tools required to perform GTAW welds in a variety of positions on various types of metal.

Taxonomy Table

Technical Skill Dimension			WEL 801E		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation						
Innovative	Complex	Simple	Cognitive Dimension		Factual	Conceptual	Procedural	Metacognitive
	D.2		Recall	Remembering				
				Understanding		D.2		
B.1, C.3	D.1, D.3		Procedural	Applying			C.3, D.1	
				Analysing		B.1	D.3	
A.1, B.2, B.3, B.4, C.1, C.2	D.4		Critical Thinking	Evaluating		B.2, B.3	A.1, C.1, C.2	
				Creating			D.4	B.4

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			Worksite Safety		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
			Recall	Understanding				
			Procedural	Applying				
			Procedural	Analysing			1.3	
A.1			Critical Thinking	Evaluating			1.1, 1.2	
			Critical Thinking	Creating				

Unit A: Safety
Worksite Safety

A.1

Students are expected to…
ensure work practices are followed to provide for personal safety, the safety of others, and to prevent accidents.

Achievement Indicators

Students who have achieved this outcome should be able to…

A.1.1 ensure the appropriate personal protective equipment (PPE) is properly used when working in the welding facility;

A.1.2 evalutate workplace safety at all times (OH&S and WHMIS); and

A.1.3 demonstrate the ability to prevent fires, prevent accidents, and to maintain a well-ventilated work area.

Elaboration

The safety outcomes are considered integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the welding facility. Students should be assessed on an ongoing basis and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to working safely in the CTE-Welding classroom.

Assessment of safety should focus on the following key areas:

- student's use of personal protective equipment
- student's active participation in the evaluation of their own, and others' safe work practices
- student's critical thinking in regards to their personal safety skills, others' safety skills, and the emergency action plans within the facility
- student's ability to hoist and lift vehicles in a safe and appropriate manner consistent with the safety procedures in the welding facility

While the factual knowledge required for these outcomes will be directly instructed at the beginning of the course, the assessment of these outcomes is ongoing throughout the course.

Students who are expressing an interest in continuing their learning in CTE should begin to consider purchasing their own PPE (safety glasses, welding helmets, steel-toed boots, hearing protection); however, the CTE facility must have a set of PPE equipment available for students.

Health and safety laws can be broken down into three categories:

- Acts - Establish legal authority (general principles, responsibilities, rights)
- Regulations - Outlines the legal rules (safety requirements, exposure limits, WHMIS)
- Guidelines and Codes - Outlines details (testing procedures, record keeping)

Student should be familiar with the responsibilities of government, employers, and employees as it relates to OH&S and be accountable for their rights as workers/students (the Right to Know, the Right to Participate, and the Right to Refuse).

Developing a safe attitude contributes significantly to an accident-free environment. Safe working procedures and conditions will support accident prevention and promote a healthy work environment. Safety in CTE is of primary importance at all times.

Red Seal Occupational Analysis 2014 Reference

Task 3 - Performs safety-related activities	
Sub-task 3.01 - Performs hazard assessments	
Code	Performance Criteria
A-3.01.01	inspect worksite to identify potential hazards such as poor ventilation, chemical spills, toxic fumes, H2S, electrical shocks, mechanical entanglement and potential explosions
A-3.01.02	identify risks associated with changes in environmental conditions such as weather and time of day
A-3.01.03	recognize risks associated with radiographic inspections
A-3.01.04	participate in daily safety meetings with personnel to communicate hazards
A-3.01.05	report hazards according to company policy and OH&S requirements
Sub-task 3.02 - Maintains safe work environment	
A-3.02.01	participate in site orientation and safety training
A-3.02.02	handle and store hazardous materials such as acids and compressed gases in designated areas according to company policy and WHMIS
A-3.02.03	install temporary safety protection such as barriers and caution tape according to site-or shop-specific requirements
A-3.02.04	install individual locks on lock-out devices on equipment to eliminate risk of energy entering the workspace
A-3.02.05	locate and clearly identify on-site safety locations such as first aid stations, eye wash stations, muster points and fire extinguishers
A-3.02.06	practice good housekeeping
A-3.02.07	plan safe route when moving material
A-3.02.08	ensure stationary machines' range of motion is unobstructed, guarded and well-marked
A-3.02.09	ensure work site complies with requirements on safe work permits such as hot work permits and confined space entry permits
A-3.02.10	protect combustible materials, or remove them from work area
Sub-task 3.03 - Uses personal protective equipment (PPE)and safety equipment	
A-3.03.01	select PPE and safety equipment according to task,hazard, company policy and OH&S regulations
A-3.03.02	store and maintain PPE and safety equipment according to manufacturers' specifications
A-3.03.03	inspect for unsafe, worn, damaged, expired and defective PPE and safety equipment,and remove from service
A-3.03.04	adjust PPE such as hard hats, respirators, hearing protection and fall arrest harnesses to ensure proper fit
A-3.03.05	wear PPE and operate safety equipment according to manufacturers' specifications and safe working practices

Internet Search

For more details on information related to these outcomes, use the following key word searches for current sites.

- Canadian Centre for Occupational Health and Safety-Young Workers
- WHMIS (webpage and/or image search)
- Young Workers Canada (webpage, image, and/or video search)
- Classes of fires (web page and/or image search)
- Fire Equipment Manufacturers Association (search site for portable fire extinguishers)

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			Employability Skills		Knowledge Dimension			
Naturalization / Articulation	Precision / Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
			Recall	Understanding				
B.1			Procedural	Applying				
B.1			Procedural	Analysing		1.2, 1.3		1.1
			Critical Thinking	Evaluating				1.4
			Critical Thinking	Creating				

Unit B: Career Development

Employability Skills

B.1

Students are expected to…

demonstrate essential workplace employability skills.

Achievement Indicators

Students who have achieved this outcome should be able to…

B.1.1 demonstrate a positive and reflective attitude towards their work, instructors, and classmates;

B.1.2 demonstrate a productive work ethic;

B.1.3 demonstrate effective time management skills; and

B.1.4 reflect on their personal employability skills and essential skills related to the welder trade when working within the CTE-Welding program.

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension: Innovative (Naturalization, Articulation)	Technical Skill Dimension: Complex (Precision, Manipulation)	Technical Skill Dimension: Simple (Imitation)	Numeracy: Cognitive Dimension		Knowledge Dimension: Factual	Knowledge Dimension: Conceptual	Knowledge Dimension: Procedural	Knowledge Dimension: Metacognitive
			Recall	Remembering				
			Recall	Understanding				
			Procedural	Applying				
			Procedural	Analysing				
B.2			Critical Thinking	Evaluating		2.1, 2.2, 2.3, 2.4, 2.5		
			Critical Thinking	Creating				

Unit B: Career Development

Numeracy

B.2

Students are expected to…

perform essential numeracy skills to solve welding problems.

Achievement Indicators

Students who have achieved this outcome should be able to…

B.2.1 perform mathematical skills involving fractions to trade related problems;

B.2.2 perform mathematical skills involving decimals to trade related problems;

B.2.3 perform mathematical skills involving percent to trade related problems;

B.2.4 perform mathematical skills involving rate and ratio to trade related problems; and

B.2.5 perform mathematical skills involving geometry to trade related problems.

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			Literacy		Knowledge Dimension			
Naturalization / Articulation	Precision / Manipulation	Imitation						
Innovative	Complex	Simple	Cognitive Dimension		Factual	Conceptual	Procedural	Metacognitive
			Recall	Remembering				
				Understanding				
			Procedural	Applying		3.6, 3.7, 3.8		
				Analysing			3.5	
B.3			Critical Thinking	Evaluating		3.1, 3.2, 3.3,		
				Creating			3.4	

Unit B: Career Development
Literacy

B.3

Students are expected to…
enhance essential literacy skills to work effectively within the trade.

Achievement Indicators

Students who have achieved this outcome should be able to…

B.3.1 interpret codes and specifications to prepare for welding projects;

B.3.2 interpret equipment and safety manuals describing safe operating procedures;

B.3.3 interpret detailed welding procedures;

B.3.4 develop checklists to learn and follow proper work procedures and safety guidelines;

B.3.5 analyse blueprints and working diagrams to advise on materials and procedures;

B.3.6 write and maintain a logbook or portfolio of technical work;

B.3.7 discuss class assignments with peers and teachers to understand expectations; and

B.3.8 share ideas about tasks and safety issues within the CTE facility.

CTE
Gas Tungsten Arc Welding
WEL801E

Unit B: Career Development
Career Portfolio

Technical Skill Dimension			Career Portfolio		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
				Understanding				
			Procedural	Applying				
				Analysing		4.2, 4.3		
B.4			Critical Thinking	Evaluating				4.1
				Creating				4.4

B.4

Students are expected to…

create a personal CTE Portfolio to document and record employability and technical skills.

Achievement Indicators

Students who have achieved this outcome should be able to…

B.4.1 reflect on individual progress related to specific technical skills and knowledge as well as transferable skills acquired within the CTE-Welding course;

B.4.2 research opportunities available and related careers connected to the welder trade using relevant trade documents (NOA, NOC, Red Seal website, IPG);

B.4.3 research secondary and post-secondary opportunities to further engage in trade-related occupations; and

B.4.4 create a portfolio to document specific technical skills, knowledge, and transferable skills to support their career development and personal goals.

Elaboration

The outcomes in Unit B - Career Development are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the career and technical education facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Students should be assessed on these outcomes on an ongoing basis and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to employability skills, numeracy skills, literacy skills, and career development.

The factual knowledge required in Unit B should be presented to the students using relevant, trade related examples and supported by the Employability Skills 2000+ (Conference Board of Canada), the Essential Skills (HRSDC), and the Red Seal Occupational Standard for Welding Technician.

Essential Skills in CTE
Personal Management and Teamwork Skills as defined by the Conference Board of Canada 2000+ Employability Skills.

Demonstrate Positive Attitudes and Behaviours

- feel good about yourself and be confident
- deal with people, problems, and situations with honesty, integrity, and personal ethics
- recognize your own and other people's good efforts
- take care of your personal health
- show interest, initiative, and effort

Be Responsible

- set goals and priorities, balancing work and personal life
- plan and manage time, money, and other resources to achieve goals
- assess, weigh, and manage risk
- be accountable for your actions and the actions of your group
- be socially responsible and contribute to your community

Be Adaptable

- work independently or as part of a team
- carry out multiple tasks or projects
- be innovative and resourceful; identify and suggest alternative ways to achieve goals and get the job done
- be open and respond constructively to change
- learn from your mistakes and accept feedback
- cope with uncertainty

Learn Continuously

- be willing to continuously learn and grow
- assess personal strengths and areas for development
- set your own learning goals
- identify and access learning sources and opportunities
- plan for and achieve your learning goals

Work with Others

- understand and work within the dynamics of a group
- ensure that a team's purpose and objectives are clear
- be flexible; respect, and be open to and supportive of the thoughts, opinions, and contributions of others in a group
- recognize and respect people's diversity, individual differences, and perspectives
- accept and provide feedback in a constructive and considerate manner
- contribute to a team by sharing information and expertise
- lead or support when appropriate, motivating a group for high performance
- understand the role of conflict in a group to reach solutions
- manage and resolve conflict when appropriate

Participate in Projects and Tasks

- plan, design, or carry out a project or task from start to finish with well-defined objectives and outcomes
- develop a plan, seek feedback, test, revise, and implement
- work to agreed-upon quality standards and specifications
- select and use appropriate tools and technology for a task or project
- adapt to changing requirements and information continuously to monitor the success of a project or task and identify ways to improve

Numeracy in CTE

Success in any trade or technology requires that students develop strong number sense and proficiency when performing welding tasks requiring mathematical skills. Number sense develops when students connect numbers to real-life experiences, thereby allowing them to apply mathematical operations in a concrete manner to solve real contextual problems.

The intention of Numeracy in CTE is not to directly teach the math skills defined by the achievement indicators; rather it is to intentionally challenge the students with real-world technical problems that will require them to use/develop their math skills.

To support teachers in the instruction and assessment of contextual mathematics, there is a 7-step lesson planning progress call Math-in-CTE that was developed by the National Research Centre for Career and Technical Education.

Literacy in CTE

Success in any trade or technical field requires that students develop strong literacy and communication skills. Students need to be able to communicate effectively and appropriately within all aspects of the welder trade in verbal, non-verbal, electronic, and written forms.

Literacy skills as defined by the Conference Board of Canada 2000+ Employability Skills.

Communicate

- read and understand information presented in a variety of forms (e.g., words, graphs, charts, diagrams)
- write and speak so others pay attention and understand
- listen and ask questions to understand and appreciate the points of view of others
- share information using a range of information and communication technologies (e.g., voice mail, e-mail, computers)
- use relevant scientific, technological, and mathematical knowledge and skills to explain or clarify ideas

Manage Information

- locate, gather, and organize information using appropriate technology and information systems
- access, analyse, and apply knowledge and skills from various disciplines (e.g., the arts, languages, science, technology, mathematics, social sciences, and the humanities)

CTE Career Portfolio

The purpose of the CTE Career Portfolio is for students to begin to discover the purpose and relevance of their learning in the CTE environment and how it connects to their current and future goals. CTE programs offer students the opportunity to gain valuable experience working on real and relevant projects all the while building technical skills within the discipline. These experience and technical skills can open a wide range of doors for students as they progress through high school, enter the labour market, and consider their post-secondary options. It is critical that CTE teachers engage students in meaningful conversations related to the CTE-Portfolio so students are able to articulate their experience and value their learning with the CTE program.

Formative Assessment Guide

<table>
<tr><th>Naturalization/Articulation</th><th>Precision</th><th>Manipulation</th><th>Imitation</th><th></th></tr>
<tr><th>Innovative
(end of 6th course)</th><th colspan="2">Complex
(end of 3rd course)</th><th>Simple
(end of 1st course)</th><th></th></tr>
<tr><td>Students communicate and discuss solutions to welding problems using both existing and emerging terminology within trade; strategically apply mathematical reasoning and number sense to solve technical problems.</td><td colspan="2">Students use welding terminology to help solve problems; use common welding tools to solve basic complete basic tasks.</td><td>Students can communicate with others using common trade language and perform basic mathematical calculations.</td><td>Recall</td></tr>
<tr><td>Students demonstrate a work ethic that is expected of an entry level Welder Apprentice; adjust work schedules to ensure work is completed.</td><td colspan="2">Students demonstrate a work ethic that shows a commitment to both the task and the others within the group; determine work schedules and time lines to ensure work is completed.</td><td>Students can follow workplace protocols such as arriving on time, remaining on-task to complete assigned work, and working effectively as member of a group.</td><td>Procedural</td></tr>
<tr><td>Students have a clear understanding of their next steps and leverage the CTE-Portfolio to help them activate their plan for either a transition to the labour market or to post-secondary training (Apprenticeship, College, University).</td><td colspan="2">Students use the evidence in their CTE Portfolio to determine their next steps; they continue to collect evidence and deepen their understanding of career and post-secondary options available through the welder program.</td><td>Students can collect and record relevant information to begin to build their CTE Portfolio.</td><td>Critical Thinking</td></tr>
</table>

Essential Skills for Welders

Oral Communication

Welders communicate with co-workers and others on a daily basis 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 machinery such as mobile equipment, grinders, hammers, sandblasters and moving metal, which affects communication. Therefore, welders use hand signals to communicate whenever necessary, particularly from a distance.

Numeracy

Welders use money math to calculate the charge for materials and labour when preparing invoices. They also use measurement and calculation math. For example they 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.

Working with Others

Welders mostly work independently within a team environment, which includes other welders, supervisors and other tradespeople such as steamfitters/pipefitters, 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, to co-ordinate 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.

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..

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. For example, 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, and 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. Welders 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).

Reading

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

Writing

For the most part, welders write text requiring less than one paragraph. For example, they fill in information in invoices, reports, time sheets and daily logs. However, they may have to complete accident and incident reports, or write safety guidelines, which require writing of more than one paragraph.

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 H2S 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.

Red Seal Occupational Analysis 2014 Reference

Task 4 - Organizes Work	
A-4.01 - Uses documentation and reference material	
A-4.01.01	review drawings and plans to retrieve required information for job
A-4.01.02	interpret weld symbols and notes
A-4.01.03	use computers and software to access electronic reference material
A-4.01.04	interpret types of lines such as broken, hidden, centre and section lines
A-4.01.05	convert between imperial and metric measurements
A-4.01.06	extrapolate necessary data from drawings
A-4.01.07	use bill of materials on drawings to identify necessary components and materials for fabrication
A-4.01.08	complete work documents such as time sheets, machinery checklists and progress report sheets
A-4.01.09	interpret WPDS
A-4.01.10	locate required information in manuals such as codes, specifications and equipment manuals
A-4.02 - Plans job tasks	
A-4.02.01	determine required equipment,material and labour to complete job
A-4.02.02	sequence order of operations based on job specifications and task scope
A-4.02.03	schedule jobs and tasks based on availability of resources and access to site
A-4.02.04	anticipate safety requirements
A-4.02.05	coordinate tasks with co-workers and other trades
A-4.02.06	set up work area
A-4.02.07	generate cut lists and parts lists from bill of materials
A-4.03 - Organizes Materials	
A-4.03.01	gather materials required according to cut list, parts list and specifications
A-4.03.02	verify bill of materials by cross referencing with heat numbers and specifications
A-4.03.03	document use of inventory according to company policies
A-4.03.04	complete order sheet for out-of-stock materials
A-4.03.05	queue and orientate materials according to sequence of assembly
A-4.03.06	protect materials from damage using coverings such as sheathing, blankets and cardboard

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			Tool Use		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
				Understanding				
			Procedural	Applying				
				Analysing			1.7, 1.8	
C.1			Critical Thinking	Evaluating		1.4	1.1, 1.2, 1.3	1.5, 1.6
				Creating			1.9	

Unit C: Tools and Equipment

Tool Use

C.1	Students are expected to… **enhance their tactile skills involving the use and selection of tools and equipment to solve technical problems related to welding technology.**

Achievement Indicators

Students who have achieved this outcome should be able to…

C.1.1 perform welding tasks safely and effectively using hand tools;

C.1.2 perform standard operations using portable power tools safely and effectively;

C.1.3 perform standard operations using stationary power tools safely and effectively;

C.1.4 select the correct tool to perform a given task;

C.1.5 reflect on their use of tools and equipment;

C.1.6 enhance their tactile skills in the proficient use of tools and equipment;

C.1.7 demonstrate the use and safe operation of metal forming and shaping tools;

C.1.8 demonstrate procedures for cutting metals using shearing machines, cut-off saws, and metal cutting band saws; and

C.1.9 construct welding projects that require the proficient use of tools and equipment.

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Gas Tungsten Arc Welding
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Technical Skill Dimension			Oxyfuel Processes		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering	2.1		2.7	
			Recall	Understanding		2.3, 2.4	2.2	
			Procedural	Applying			2.5, 2.6	
			Procedural	Analysing				
C.2			Critical Thinking	Evaluating			2.8, 2.9	
C.2			Critical Thinking	Creating				

Unit C: Tools and Equipment

Oxyfuel Processes

C.2	Students are expected to… **perform procedures used to cut and weld with oxyfuel equipment.**

Achievement Indicators

Students who have achieved this outcome should be able to…

C.2.1 define terminology associated with oxyfuel cutting and welding;

C.2.2 identify hazards and describe safe work practices pertaining to oxyfuel cutting and welding;

C.2.3 identify oxyfuel equipment and accessories;

C.2.4 describe the applications of types of flames (oxidizing, carburizing, neutral);

C.2.5 practise the correct procedures for flame adjustment;

C.2.6 practise the procedures used to set up, adjust, and shut down oxyfuel equipment;

C.2.7 follow the procedures used to inspect and maintain oxyfuel equipment;

C.2.8 perform the procedures used to cut materials using oxyfuel equipment (free hand, guided with straight edge, guided with pattern); and

C.2.9 perform oxyfuel welding, brazing, and braze welding.

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Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			Materials Handling		Knowledge Dimension			
Naturalization / Articulation	Precision / Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
			Recall	Understanding	3.4	3.3, 3.5, 3.6, 3.7	3.1, 3.8, 3.9	
C.3			Procedural	Applying		3.2	3.10, 3.11	
			Procedural	Analysing				
			Critical Thinking	Evaluating				
			Critical Thinking	Creating				

Unit C: Tools and Equipment

Materials Handling

C.3

Students are expected to…
apply safe procedures for handling materials.

Achievement Indicators

Students who have achieved this outcome should be able to…

C.3.1 identify safe procedures for handling and storing materials;

C.3.2 determine weight and centre of gravity of loads;

C.3.3 describe the effect that sling angles have on safe lifting;

C.3.4 identify the load limits of commonly used wire rope slings and synthetic slings;

C.3.5 describe the causes and effects of shock loading on rigging;

C.3.6 describe the care and use of wire rope, synthetic rope, and chains;

C.3.7 describe the correct use of plate clamps;

C.3.8 describe the correct procedure for applying cable clips;

C.3.9 describe proper procedures for lifting and carrying loads;

C.3.10 practise following lifting and carrying procedures; and

C.3.11 practise storing materials and supplies in a safe manner.

CTE

Gas Tungsten Arc Welding
WEL801E

Unit C: Tools and Equipment

Arc Cutting and Gouging

Technical Skill Dimension			Arc Cutting and Gouging		Knowledge Dimension			
Naturalization / Articulation	Precision / Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
				Understanding				
			Procedural	Applying				
				Analysing				
C.4			Critical Thinking	Evaluating			4.1, 4.2, 4.3, 4.4	
				Creating				

C.4	Students are expected to… **perform plasma and carbon arc cutting and gouging.**

Achievement Indicators

Students who have achieved this outcome should be able to…

C.4.1 troubleshoot the carbon arc cutting process;

C.4.2 perform air carbon arc cutting;

C.4.3 troubleshoot the plasma arc cutting process; and

C.4.4 perform plasma arc cutting.

Elaboration

The outcomes in Unit C - Tools and Equipment are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the career and technical education facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Developing students' skill and proficiency in working with their hands is critical to the success of anyone interested in pursuing a career in the skilled trades. Students need to be provided time to practise their skills using hand tools, power tools, and stationary power equipment on a variety of projects and applications.

The outcomes in this unit are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the welding facility. This outcome requires the students to use hand tools, portable tools, and stationary power tools in a safe and appropriate manner consistent with the safety procedures in the CTE facility.

While the factual knowledge and use of hand tools, power tools, and stationary equipment required in these outcomes will be directly instructed and demonstrated, these outcomes should be assessed on an ongoing basis and students should be given timely, formative feedback to enable them to deepen their knowledge and develop their skills related to the use of these tools.

Teachers should consider developing an instructional plan that provides students with a broad overview of all the hand tools, power tools and stationary equipment they will need during the course. This should be followed up with specific instruction, direction, and demonstration of the skill when the task is required.

Measuring Tools	Hand Tools	Portable and Stationary Equipment
chalk lines	aviation snips	oxy-acetylene torches
combination squares	clamps	welding equipment
compass	drill bits	drill press
dividers	files	grinders
fillet gauge	hack saw	iron workers
framing squares	hammers	portable grinders
levels	pop rivet gun	portable drills
measuring tapes	pliers	metal lathe
micrometer	pry bars	
torpedo level	screwdrivers	
tri-square	soldering iron	
steel rules	socket sets	
	tap and die sets	
	wrenches	

Performance Indicators for Oxyfuel

- Describing the cutting process of rapid oxidation.
- Defining drag, heat energy, kerf, kerf lines, and torch inclination.
- Determining problems with cutting speed by visually inspecting kerf lines.
- Identifying the gases used for oxyfuel cutting.
- Describing the characteristics of the gases used for oxyfuel cutting.
- Identifying and describing the functions of the three types of torches.
- Identifying and describing two types of mixing systems on hand torches.
- Identifying and describing tracing systems for machine cutting equipment.
- Identifying the four basic types of tips and stating their basic functions (straight tip, scarfing tip, gouging tip, heavy duty rivet/bolt tip).
- Identifying factors that will determine which tip to select.
- Demonstrating the proper method for cleaning the tip.
- Demonstrating the ability to properly light the torch.
- Identifying problems with the preheat flames and cutting jet stream.
- Describing how to start a cut.
- Demonstrating the proper torch inclination for the gauge of material being cut.
- Demonstrating and describing two methods of piercing a hole through solid plate.
- Describing the process of stack cutting.
- Explaining why metals such as cast iron, stainless steel, and non-ferrous metals are difficult to cut using an oxyfuel system.
- Identifying and explaining corrective measures for common cutting faults.
- Demonstrating and describing the three common methods of controlling the cutting torch (across cut, push cut, pull cut).
- Selecting and wearing the appropriate personal protective equipment.
- Describing filler rods and fluxes.
- Demonstrating the ability to run lines of fusion with and without fuller rods in the flat and vertical positions.
- Demonstrating the ability to weld lap joints on 10 gauge or 11 gauge (3.00-3.25 mm) mild steel in the horizontal (2F) and the vertical (3F) positions using a comparable filler material.
- Demonstrating the ability to weld butt joints on 10 gauge or 11 gauge (3.00-3.25 mm) mild steel in the flat (1G) and the vertical (2G) positions using a comparable filler material.
- Demonstrating the ability to weld lap joints on 10 gauge (3.00-3.25 mm) mild steel in the vertical position using a braze welding filler material.

Performance Indicators for Materials Handling

- Calculating the weight of an object to be lifted.
- Defining centre of gravity.
- Describing the effect of lifting an unstable load when the centre of gravity is not located directly below the hook.
- Understanding proper lifting and hoisting procedures.
- Defining sling angle.
- Describing the rated capacity of a sling.
- Describing the effect that sling angle has on the weight distribution across the legs.
- Describing advantages of wire rope slings.
- Defining working load limit.
- Describing the advantages of synthetic slings.
- Demonstrating manufacturers' specifications for web slings.
- Defining shock loading.
- Describing how to avoid shock loading.
- Referencing sections of the P.E.I. Occupational Health and Safety Act that apply to rigging equipment.
- Interpreting Occupational Health and Safety Regulations.
- Defining softeners and describing their function.
- Describing the types of stress and abuse that are applied to slings.
- Demonstrating performing visual inspections of rope and slings.
- Describing the function of the tag line.
- Describing factors that can cause an uneven loading on sling legs.
- Describing the function of spreader beams.
- Stating the importance of levelling a crane.
- Describing procedures for levelling a crane.
- Describing factors that affect the lifting of any load.
- Defining load radius deflection.
- Describing precautions to follow when hoisting and carrying a load.
- Describing the function of plate clamps.
- Describing the function of wire rope clips.

Performance Indicators for CAC-A & PAC

- Defining “arc cutting”.
- Describing how to select the appropriate arc cutting process for any given job in reference to effectiveness, limitations of the process, type of power sources available, and safety precautions.
- Explaining the CAC-A process.
- Labeling a diagram of the CAC-A process.
- Describing the equipment used for CAC-A.
- Understanding of the safety precautions related to CAC-A.
- Stating a variety of applications for CAC-A.
- Describing the metals on which CAC-A can effectively be applied.
- Describing the function and construction of electrodes used in CAC-A.
- Describing the function and minimum requirements of the air supply used for CAC-A.
- Describing the metallurgical effects of carbonizing and surface hardening, and explain how to prevent and recognize these problems.
- Demonstrating the correct set up of equipment perform PAC cutting operations.
- Describing the proper technique and set-up in reference to the following as they relate to obtaining a quality cut: electrode stick-out, starting of the arc, electrode inclination, and work angle.
- Understanding of possible solutions to problems related to the PAC process.
- Explaining the PAC process.
- Defining terminology related to PAC.
- Labeling a diagram of the PAC process.
- Understanding of the safety precautions related to PAC.
- Describing the equipment used for PAC.
- Explaining the construction and components of a plasma cutting torch.
- Describing the metallurgical effects that may occur as a result of PAC.
- Demonstrating the proper technique and set-up in reference to the following as they relate to obtaining a quality cut: travel speed, standoff distance, gases and flow rates.

Red Seal Occupational Analysis 2014 Reference

Task 8- Uses tools and equipment for non-thermal cutting and grinding	
C-8.01 - Selects cutting and grinding tools	
C.8.02 - Cuts using stationary band saws and power hacksaws	
C.8.03 - Cuts using shears and ironworkers	
C.8.04 - Cuts using hand tools	
C.8.05 - Cuts using handheld power tools	
Task 9- Uses oxy-fuel gas cutting (OFC) process for cutting and gouging	
C-9.01 - Selects OFC gas and equipment	
C-9.01.01	choose type of regulators such as single and double stage, according to application and gas type
C-9.01.02	choose type of torch and size of hoses according to application
C-9.01.03	choose type and size of tip according to application
C-9.01.04	choose type of fuel gas according to availability and job task
C-9.01.05	identify and choose oxygen and fuel cylinders/manifolds by suppliers' labels
C-9.01.06	choose manual or mechanized torch cutting systems such as track and pipe beveling cutters, according to application
C-9.02 - Sets up OFC equipment	
C-9.02.01	move and secure oxygen and fuel cylinders to prevent damage to cylinder and property, and to prevent injury to personnel
C-9.02.02	remove cylinder caps, open and close cylinder valves to remove debris from valve, according to manufacturers' specifications
C-9.02.03	install regulators on fuel and oxygen cylinders, according to set-up procedures
C-9.02.04	install flashback arrestors at the regulators and torch according to manufacturers' specifications and jurisdictional regulations
C-9.02.05	connect hoses to regulators and torch to hoses to provide gases for cutting according to manufacturers' specifications
C-9.02.06	loosen (back-off) pressure-adjusting screws on regulators to prevent damage to regulators
C-9.02.07	open cylinder valves according to manufacturers' specifications
C-9.02.08	purge system by opening torch valves and tightening pressure-adjusting screws on regulators
C-9.02.09	close torch valves
C-9.02.10	check for leaks at all connection points with approved leak detecting solution
C-9.03 - Sets operating parameters for OFC equipment	
C-9.03.01	remove possible contaminants from tips by using tip cleaners
C-9.03.02	adjust working pressures on regulators according to manufacturers' recommendations for the application
C-9.03.03	light torch and adjust oxygen to fuel ratio to obtain required flame for application
C-9.03.04	perform trial cut to verify operating parameters and tip selection
C-9.04 - Performs cut and gouge using OFC equipment	
C-9.04.01	ignite fuel gas and adjust torch valves for type of flame such as neutral, carburizing and oxidizing
C-9.04.02	pre-heat material to kindling (auto-ignition) point, initiate cut and proceed with cutting

C-9.04.03	detect and correct defects to ensure quality of cut
C-9.04.04	adjust and maintain travel speed and torch angle taking into consideration factors such as base metal, thickness of base metal and heat input to achieve a consistent cut or gouge
C-9.04.05	recognize and correct backfire and flashback conditions
C-9.04.06	recognize defects such as creep and leaks,and remove regulators from service
C-9.04.07	shut down equipment according to safe operating procedures and manufacturers' recommendations
Task 10 - Uses plasma arc cutting (PAC)process for cutting and gouging	
C-10.01 - Selects PAC equipment and consumables	
C-10.01.01	choose size of PAC system according to thickness and type of material
C-10.01.02	choose PAC consumables such as tips, electrodes and nozzles according to cutting or gouging requirements
C-10.01.03	choose manual or mechanized PAC systems such as track and pipe beveling cutters, according to application
C-10.01.04	choose air or gas according to type of material
C-10.02 - Sets up PAC equipment	
C-10.02.01	visually check equipment and components for damage
C-10.02.02	assemble PAC components on torch head
C-10.02.03	connect torch to power source
C-10.02.04	set up regulator according to manufacturers' specifications
C-10.02.05	attach ground clamp to base metal and ensure conductivity
C-10.03 - Sets operating parameters for PAC equipment	
C-10.03.01	set amperage according to thickness and type of base metal
C-10.03.02	set and check air pressure according to manufacturers' specifications
C-10.03.03	perform trial cut to check for cut defects
C-10.04 - Performs cut and gouge using PAC equipment	
C-10.04.01	apply PAC techniques such as initiating the arc and cut, and starting at the correct stand-off distance
C-10.04.02	detect and correct defects to ensure quality of cut or gouge
C-10.04.03	recognize when components are in need of replacement
C-10.04.04	adjust and maintain travel speed taking into consideration factors such as type and thickness of base metal and heat input to achieve a consistent cut or gouge
C-10.04.05	detect equipment malfunctions such as low gas pressure and inadequate ground
C-10.04.06	use jigs and guides during cutting operations
C-10.04.07	shut down equipment according to safe operating procedures and manufacturers' recommendations
Task 11 - Uses air carbon arc cutting (CAC-A) process for cutting and gouging	
C-11.01 - Selects CAC-A equipment and consumables	
C-11.02 - Sets up CAC-A equipment	
C-10.03 - Sets operating parameters for CAC-A equipment	
C-10.04 - Performs cut and gouge using CAC-A equipment	

Technical Skill Dimension			GTAW Process		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
			Recall	Understanding	D.4, D.5, D.9	D.1, D.2, D.8		
	D.1		Procedural	Applying			D.3, D.7	
			Procedural	Analysing				
			Critical Thinking	Evaluating				
			Critical Thinking	Creating				

Unit D: Welder Processes

GTAW Process

D.1

Students are expected to…

apply safe work practices and procedures when using GTAW.

Achievement Indicators

Students who have achieved this outcome should be able to…

D.1.1 explain the GTAW process and applications;

D.1.2 explain the advantages and disadvantages of the GTAW process;

D.1.3 practise protective measures to follow when working with GTAW;

D.1.4 identify the basic components of a GTAW work station;

D.1.5 describe types of GTAW power sources;

D.1.6 identify welding currents used in GTAW (e.g., AC current, DC current, high frequency current);

D.1.7 practise setting up the torch assembly; and

D.1.8 describe gas regulators and flowmeters.

Performance Indicators

- Explaining the GTAW process and describing applications of GTAW.
- Describing the GTAW spot welding process.
- Stating advantages and disadvantages of GTAW spot welding.
- Describing hot and cold wire GTAW.
- Stating advantages and disadvantages of hot and cold wire GTAW.
- Appling and describing safety measures to be taken with GTAW in reference to: electrical shock, eye, face, and hearing protection (PPE), fire prevention, ventilation.
- Identifying the components of a GTAW work station.
- Describing the process of pulsed GTAW and discuss its advantages.
- Describing factors that affect the type of power source required.
- Defining drooping.
- Stating the classifications of power sources.
- Describing the features and controls built into a full function GTAW power source.
- Defining amperage and voltage.
- Identifying the welding currents used for GTAW.
- Describing the resulting welding characteristics unique to each current type and polarity.
- Describing the function and process of each of the following welding currents: direct current electrode negative (DCEN), direct current electrode positive (DCEP), alternating current.
- Defining arc rectification and DC component.
- Listing features that help with arc starting and arc stability.
- Describing the principles of operation and discussing the advantages and disadvantages of the following: high-frequency current, high voltage injection, AC square wave output, AC unbalanced and balanced wave control.
- Identifying proper welding current for a variety of metals.
- Describing the characteristics of both air-cooled and water-cooled torches.
- Describing how GTAW torches are rated.
- Identifying the components of both an air-cooled and water-cooled torch.
- Describing the function of each of the following components: torch cap, torch body, collet body and electrode collet, gas nozzles, gas lenses.
- Assembling a GTAW torch with the correct equipment to perform a weld.
- Describing the function of a regulator.
- Describing the function of a flowmeter.
- Discussing points to consider when selecting a regulator and/or flowmeter.
- Describing the function and characteristics of shielding gas hoses.
- Describing the function of the solenid valves.
- Reading and interpreting WHMIS MSDS on compressed gas cylinders.
- Demonstrating how to assemble the gas cylinder valve and regulators.
- Demonstrating how to adjust gas flow rate to required working rate.

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension					GTAW Consumables		Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension					
		D.2			Recall	Remembering				
					Recall	Understanding	2.2, 2.5, 2.6, 2.8	2.1, 2.4, 2.9	2.3, 2.7	
					Procedural	Applying				
					Procedural	Analysing				
					Critical Thinking	Evaluating				
					Critical Thinking	Creating				

Unit D: Welder Processes
GTAW Consumables

D.2

Students are expected to…
choose GTAW electrodes, filler metals, and gases.

Achievement Indicators

Students who have achieved this outcome should be able to…

D.2.1 explain the function of the electrode in GTAW;

D.2.2 identify electrodes by AWS designations and explain their applications;

D.2.3 describe the care and preparation of electrodes;

D.2.4 explain the function of the filler metals in GTAW;

D.2.5 identify filler metals by AWS and CSA designations and explain their applications;

D.2.6 identify types and purpose of consumable inserts;

D.2.7 describe the care and handling of filler metals;

D.2.8 identify the types and applications of shielding gases used in GTAW; and

D.2.9 explain the advantages and disadvantages of various types of shielding gases.

Performance Indicators

- Describing the function of the electrode used for GTAW and stating the characteristics of tungsten that make it an effective electrode.
- Stating the four alloying elements used to create tungsten alloys.
- Interpreting AWS specifications for identifying GTAW electrodes.
- Stating factors to consider when selecting a tungsten electrode.
- Describing the function and intended use of common GTAW electrodes.
- Describing the finish on the electrode.
- Interpreting data related to electrode selection from manufacturers' tables and specifications.
- Describing the purpose of preparing electrodes.
- Stating the application of tapered ends.
- Stating the application of balled ends.
- Demonstrating the three methods of preparing electrodes.
- Explaining why grinding marks should be longitudinal.
- Discussing how to keep an electrode in good condition when welding.
- Practising safe work habits when handling and preparing electrodes.
- Describing factors that influence electrode end conditions.
- Predicting potential problems based on the condition of the electrode.
- Identifying various forms of filler metals.
- Describing factors to consider when selecting a filler metal.
- Describing AWS and CSA designations.
- Interpreting specification tables related to filler metals for GTAW.
- Explaining the characteristics of commonly used filler metals.
- Describing advantages of using consumable inserts.
- Identifying various forms of consumable inserts and state their intended function.
- Practising proper care and handling of filler metals.
- Defining terms related to shielding gases.
- Interpreting WHMIS information.
- Explaining the function of the shielding gas.
- Stating the general application of each of the following shielding gases used for GTAW: argon, helium, nitrogen, argon helium, argon hydrogen.
- Demonstrating regulating shielding gas flow rates.
- Demonstrating the advantages of various shielding gases.
- Demonstrating the disadvantages of various shielding gases.

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			GTAW Equipment		Knowledge Dimension			
Naturalization, Articulation	Precision, Manipulation	Imitation			Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension					
			Recall	Remembering				
				Understanding				
	D.3		Procedural	Applying				
				Analysing			3.1, 3.23.3, 3.4	
			Critical Thinking	Evaluating				
				Creating				

Unit D: Welder Processes

GTAW Equipment

D.3	Students are expected to… **inspect GTAW equipment.**

Achievement Indicators

Students who have achieved this outcome should be able to…

D.3.1 demonstrate corrective measures to solve identified power source output current problems;

D.3.2 demonstrate corrective measures to solve identified GTAW torch and cable assembly problems;

D.3.3 demonstrate the care and handling of GTAW equipment and components; and

D.3.4 demonstrate corrective measures to solve identified shielding gas coverage problems.

Performance Indicators

- Describing factors to consider when setting up and maintaining GTAW power sources; location and hookup of the welding power source, torch assembly, shielding gas and gas control system, work lead, high-frequency current system, shut-down procedures.
- Interpreting manufacturers' information related to GTAW equipment maintenance.
- Describing factors to consider when setting up and maintaining GTAW torch and cable assemblies; torch handle and head, air-cooled GTAW torches, gas control valves, cable covers, nozzles, collet and collet body, gas lens, electrode condition.
- Interpreting manufacturers' information related to GTAW torches and cable assemblies.
- Demonstrating the proper care and handling of the following components of the GTAW outfit; regulator/ flowmeter unit, hoses, remote control switches, cooling systems.
- Describing the following common problems related to shielding gases: inadequate gas flow, excessive gas flow, incorrect gas selection.
- Describing the three categories of weld faults: process, electrical, mechanical.
- Demonstrating the ability to diagnose GTAW weld faults related to the categories above.

CTE

Gas Tungsten Arc Welding
WEL801E

Technical Skill Dimension			GTAW Welding		Knowledge Dimension			
Innovative (Naturalization, Articulation)	Complex (Precision, Manipulation)	Simple (Imitation)	Cognitive Dimension		Factual	Conceptual	Procedural	Metacognitive
			Recall	Remembering				
			Recall	Understanding				
			Procedural	Applying				
			Procedural	Analysing			4.1, 4.3	
	D.4		Critical Thinking	Evaluating			4.2, 4.4, 4.5, 4.6	
			Critical Thinking	Creating			4.7, 4.8	

Unit D: Welder Processes

GTAW Welding

D.4

Students are expected to…

construct welding projects and repairs using GTAW process safely and efficiently.

Achievement Indicators

Students who have achieved this outcome should be able to…

D.4.1 demonstrate striking an arc using the touch start or lift start and high-frequency methods;

D.4.2 perform weld stringer beads in the flat position on mild steel gauge plate;

D.4.3 demonstrate the ability to prepare joints for GTAW on mild steel gauge plate;

D.4.4 perform weld fillet welds in the 1F position on mild steel gauge plate;

D.4.5 perform weld fillet welds in the 2F position on mild steel gauge plate;

D.4.6 perform weld fillet welds in the 3F position on mild steel gauge plate;

D.4.7 design welding projects requiring GTAW process welds; and

D.4.8 repair welds and welding projects using the GTAW process.

Performance Indicators

- Demonstrating an understanding of the factors to consider when assessing the value of any welding technique.
- Describing and practising safety procedures related to GTAW processes.
- Interpreting welding procedure specifications.
- Creating welding procedure specifications.
- Performing welding techniques used for GTAW.
- Demonstrating the ability to start the arc by means of each of the following starts:
    - *scratch start*
    - *high frequency start*
    - *lift start*
- Selecting the correct materials.
- Preparing the correct materials.
- Preparing the work area.
- Interpreting welding parameters.
- Evaluating the quality of the final weld.

Red Seal Occupational Analysis 2014 Reference

Task 5 - Performs routine trade activities	
A-5.01 - Performs quality inspection	
A.5.02 - Marks welds, materials and parts	
A.5.04 - Stores welding consumables	
Task 6 - Performs layout	
B-6.02 - Transfers dimensions from drawings to materials	
B-6.01.01	extract information from drawings and weld symbols
B-6.01.02	determine work points such as centre lines, hole locations and end preparation lines to determine location and orientation of components according to drawings
B-6.01.03	select and use measuring and layout tools such as combination squares, measuring tapes, plumb bobs and marking devices
B-6.01.04	establish working point and axis to determine starting point
B-6.01.05	perform mathematical calculations such as conversions, ratios and proportions
B-6.01.06	consider factors such as size, material usage and seam location to maximize efficiency and quality
B-6.01.07	determine total material required by considering factors such as bend allowances, kerf and job requirements
B-6.01.08	verify layout for accuracy according to drawings, specifications, and company policies and procedures
Task 7 - Fabricates components	
B.7.01 - Prepares materials.	
B.7.02 - Fits components for welding	
B.7.03 - Assembles components	
Task 14 - Welds using gas tungsten arc welding (GTAW) process	
D.14.01 - Selects GTAW gas, equipment and consumables	
D.14.01.01	select power source such as inverters, rectifiers and generators, according to the task
D.14.01.02	select shielding gas taking into consideration factors such as base metal composition and WPS/WPDS
D.14.01.03	select cups and diffusers taking into consideration factors such as joint type and shielding gas
D.14.01.04	select tungsten electrode and filler rod compositions and diameters taking into consideration base metal thickness and composition, joint type, position and WPS/WPDS to ensure fusion and avoid weld defects
D.14.01.05	select welding attachments/equipment such as ground clamps, torches and cables(leads), regulators/flow meters, shielding gases and hoses according to application
D.14.02 - Sets up GTAW equipment	
D.14.02.01	set control on power source to GTAW process and use high frequency settings according to application
D.14.02.02	connect cables (leads) to power source

D.14.02.03	connect regulator/flow meter to gas supply and hoses
D.14.02.04	assemble torch components such as tungsten electrodes, gas diffusers, cups, collets, collet bodies and gas lenses, and connect assembly to power source
D.14.02.05	adjust tungsten electrode stick-out according to joint configuration
D.14.02.06	set required polarity bya djusting selector switch or connecting cables (leads) to appropriate terminals
D.14.02.07	attach ground to base metal to complete circuit
D.14.02.08	dam and/or purge taking into consideration factors such as joint configuration, position and base metal composition
D.14.02.09	prepare tungsten electrode by sharpening or balling it to desired tip shapebased on application
D.14.03 - Sets operating parameters for GTAW	
D.14.03.01	interpret WPS/WPDS to determine parameters for application
D.14.03.02	set amperage, polarity and frequency to match parameters according to the base metal type and thickness, size and composition of the filler rod, and position of the weld
D.14.03.03	set shielding gas flow rate, including pre-and post-flow time, according to manufacturers' recommendations for application
D.14.03.04	verify set-up by welding a test specimenof same base metal and filler rod
D.14.03.05	adjust flow rate of gas to meet purging requirements
D.14.04 - Performs weld with GTAW equipment	
D.14.04.01	start up and shut down equipment according to safe operating procedures and manufacturers' recommendations
D.14.04.02	manipulate torch while maintaining torch angle and arc length, and using backhand (pull) and forehand (push) techniques to direct heat and control penetration
D.14.04.03	manipulate torchusing techniques such as weave andstringer to deposit weld metal, while adding filler metal according to factors such as application,joint configuration, position and WPS/WPDS
D.14.04.04	adjust amperage with and without remote amperage controls
D.14.04.05	match filler rod feed,travel speed and angle of torch taking into consideration factors such as base metal, joint configuration, position and heat input to maintain a consistent weld profile
D.14.04.06	start, stop and properly re-start arc to ensure proper tie-ins and avoid welding defects
D.14.04.07	visually inspect weld to identify weld faults
D.14.04.08	troubleshoot GTAW equipment and process to determine cause of weld fault
D.14.04.09	correct weld faults using methods such as grinding/gouging and re-welding
D.14.04.10	finish weld showing proper tie-ins in all positions and containing no unacceptable welding defects