



# **Grades 9 to 12 Welding Technology**

Manitoba Technical-Vocational  
Curriculum Framework  
of Outcomes





GRADES 9 TO 12  
WELDING TECHNOLOGY

Manitoba Technical-Vocational Curriculum  
Framework of Outcomes

Manitoba Education Cataloguing in Publication Data

Grades 9 to 12 welding technology : Manitoba  
technical-vocational curriculum framework of outcomes

Includes bibliographical references

ISBN: 978-0-7711-6394-4 (pdf)

1. Welders (Persons)—Vocational guidance.
2. Welding—Study and teaching (Secondary)—Manitoba.
3. Welding industry—Study and teaching (Secondary)—Manitoba.
4. Technical education—Manitoba—Curricula.
5. Vocational education—Manitoba—Curricula.

I. Manitoba. Manitoba Education.

671.520712

Copyright © 2019, the Government of Manitoba, represented by the Minister of Education.

Manitoba Education  
Winnipeg, Manitoba, Canada

Every effort has been made to acknowledge original sources and to comply with copyright law. If cases are identified where this has not been done, please notify Manitoba Education. Errors or omissions will be corrected in a future edition. Sincere thanks to the authors and publishers who allowed their original material to be used.

Any websites referenced in this resource are subject to change without notice. Educators are advised to preview and evaluate websites and online resources before recommending them for student use.

This resource is available on the Manitoba Education website at  
[www.edu.gov.mb.ca/k12/cur/teched/sy\\_tech\\_program.html](http://www.edu.gov.mb.ca/k12/cur/teched/sy_tech_program.html).

Available in alternate formats upon request.

# CONTENTS

---

<b>Acknowledgements</b>	v
-------------------------	---

---

<b>Technical-Vocational Education Overview</b>	1
------------------------------------------------	---

---

<b>Welding Technology Overview</b>	1
------------------------------------	---

Welding Technology as a TVE Cluster	2
2017 Revisions to the Welding Technology Curriculum	2
Role of Welders	2
Career and Employment Opportunities in Welding Technology	2
Implementation of the Welding Technology Cluster	3
Level 1 Apprenticeship for Welder	3
The Multi-Course and Individual-Course Formats	4
Trade Safety Awareness Manual	5
Red Seal Resources	5
Qualifications of Welding Technology Teachers	5
Comparison of Welding Technology with Industrial Arts Metalwork Technology	6
Welding Technology and Industrial Arts Metalwork Technology Comparison Chart	7
Welding Technology Goals and General Learning Outcomes (GLOs)	8
Specific Learning Outcomes (SLOs)	9

Course Descriptions	9
8377 Exploration of Welding Technology	9
8378 Introduction to Welding Technology	9
8414 Metal Design/Fabrication & Oxy-Acetylene Procedures	9
8474 Basic GMAW (MIG) Procedures	10
8486 Basic SMAW (ARC) Procedures	10
8487 Advanced GMAW (MIG) Procedures	10
8488 Advanced SMAW (ARC) Procedures	10
8489 Advanced Metal Design/Fabrication	10
8503 Applied Specialties and Qualifications	10
Guide to Reading Welding Technology Goals and Learning Outcomes	11

---

## **Grades 9 to 11 Welding Technology: General and Specific Learning Outcomes by Goal**

Goal 1: Describe and apply health and safety practices.	15
Goal 2: Demonstrate an understanding of metallurgy.	22
Goal 3: Demonstrate the identification, operation, maintenance, and storage of equipment, materials, and consumable items.	24
Goal 4: Demonstrate an understanding of welding processes and exhibit competence in those processes.	28
Goal 5: Demonstrate an understanding of metal design and fabrication.	32
Goal 6: Describe and apply the transferable cross-curricular knowledge and skills.	34
Goal 7: Follow the ethical and legal standards that pertain to the welding industry.	37

Goal 8: Demonstrate employability skills.	38
Goal 9: Demonstrate an awareness of sustainability as it pertains to the welding industry.	39
Goal 10: Demonstrate an understanding of the structure and scope of welding.	40
Goal 11: Demonstrate an understanding of the evolution, technological progression, and emerging trends in welding.	41

Goal 11: Demonstrate an understanding of the evolution, technological progression, and emerging trends in welding.	68
--------------------------------------------------------------------------------------------------------------------	----

---

<b>Bibliography</b>	<b>69</b>
---------------------	-----------

---

<b>Grade 12 Welding Technology: General and Specific Learning Outcomes by Goal</b>	<b>43</b>
------------------------------------------------------------------------------------	-----------

Goal 1: Describe and apply health and safety practices.	45
Goal 2: Demonstrate an understanding of metallurgy.	48
Goal 3: Demonstrate the identification, operation, maintenance, and storage of equipment, materials, and consumable items.	49
Goal 4: Demonstrate an understanding of welding processes and exhibit competence in those processes.	56
Goal 5: Demonstrate an understanding of metal design and fabrication.	60
Goal 6: Describe and apply the transferable cross-curricular knowledge and skills.	62
Goal 7: Follow the ethical and legal standards that pertain to the welding industry.	64
Goal 8: Demonstrate employability skills.	64
Goal 9: Demonstrate an awareness of sustainability as it pertains to the welding industry.	66
Goal 10: Demonstrate an understanding of the structure and scope of welding.	67

## ACKNOWLEDGEMENTS

Manitoba Education gratefully acknowledges the contributions of the following individuals in the development of *Grades 9 to 12 Welding Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes*:

<b>Members of the 2017 Curriculum Update Team</b>	Gerard Hoorne	Murdoch MacKay Collegiate River East Transcona School Division
	Toby Punton	Technical Vocational High School Winnipeg School Division
	Dean Zaluski	Steinbach Regional Secondary School Hanover School Division
<b>Members of the 2015 Curriculum Update Team</b>	Zenon Kinasevych	Sturgeon Heights Collegiate St. James-Assiniboia School Division
	Toby Punton	Technical Vocational High School Winnipeg School Division
	Dean Zaluski	Steinbach Regional Secondary School Hanover School Division
<b>Members of the 2012–2013 Curriculum Development Team</b>	Jamie Irwin	Crocus Plains Regional Secondary School Brandon School Division
	Mike Johnston	R. B. Russell Vocational School Winnipeg School Division
	Toby Punton	Technical Vocational High School Winnipeg School Division
	Riaan Strydom	Morden Collegiate Western School Division

**Manitoba Education  
Staff**

Carole Bilyk  
Coordinator (until June 2016)

Development Unit  
Instruction, Curriculum and Assessment Branch

Louise Boissonneault  
Coordinator

Document Production Services Unit  
Instruction, Curriculum and Assessment Branch

John Finch  
Coordinator

Learning Support and Technology Unit  
Instruction, Curriculum and Assessment Branch

Kristin Grapentine  
Desktop Publisher

Document Production Services Unit  
Instruction, Curriculum and Assessment Branch

Gilles Landry  
Consultant

Learning Support and Technology Unit  
Instruction, Curriculum and Assessment Branch

Grant Moore  
Publications Editor

Document Production Services Unit  
Instruction, Curriculum and Assessment Branch

Kim Poirier  
Consultant

Learning Support and Technology Unit  
Instruction, Curriculum and Assessment Branch

## TECHNICAL-VOCATIONAL EDUCATION OVERVIEW

In 2013, Manitoba Education released the document *Technical-Vocational Education Overview* (available at [www.edu.gov.mb.ca/k12/cur/teched/sy\\_tech\\_program.html](http://www.edu.gov.mb.ca/k12/cur/teched/sy_tech_program.html)) to provide the philosophical and pedagogical underpinnings for curriculum development and the teaching of technical-vocational education (TVE) courses in Manitoba. This overview presents educators with the vision and goals of TVE in Manitoba.

Topics include the following:

- curriculum revitalization and renewal
- curriculum framework and implementation
- articulation of programming
- assessment and reporting
- safety
- employability/essential skills and career development
- sustainable development

TVE clusters of courses are designed to encourage students to explore career options in designated trades and trained occupations, and to address labour shortages in these areas. The TVE curriculum includes course clusters for both *designated trades* (those designated for apprenticeship training and certification by Apprenticeship Manitoba) and *trained occupations* (those not designated as trades).

The TVE curriculum is significantly different from other subject areas such as industrial arts. It has distinct qualities that, when respected, will provide students with a uniquely valuable experience that they cannot receive from any other curriculum.

TVE gives students the opportunity to learn the theoretical and practical aspects of one specific trade or trained occupation in order to facilitate their transition from school to work or to post-secondary education in that trade or trained occupation (including journeyman status from Apprenticeship Manitoba), or into an associated trade or occupation. This transition is accomplished by having students complete an entire TVE cluster of courses, learning from industry-certified teachers with industry experience in a setting that, as much as possible, emulates an actual workplace.

The TVE curriculum includes Grades 9 to 12 courses in a variety of areas, including welding technology.

## WELDING TECHNOLOGY OVERVIEW

*Grades 9 to 12 Welding Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes* identifies the goals, general learning outcomes (GLOs), and specific learning outcomes (SLOs) for nine welding technology courses. This framework is intended for use in all Manitoba schools teaching welding technology as part of the Senior Years Technology Education Program.

## Welding Technology as a TVE Cluster

*Grades 9 to 12 Welding Technology: Manitoba Technical-Vocational Framework of Outcomes* has been developed as a technical-vocational education (TVE) cluster of courses.

The welding technology curriculum prepares students for careers as welders. Welding has been designated as a trade by the regulations under the *Apprenticeship and Certification Act* (Manitoba), and is administered by Apprenticeship Manitoba. For more information on trade programs, refer to *Manitoba Trades* on the Apprenticeship Manitoba website at [www.manitoba.ca/wd/apprenticeship/discover/mbtrades/index.html](http://www.manitoba.ca/wd/apprenticeship/discover/mbtrades/index.html).

Like all other TVE courses, the welding technology courses should be taught only as part of a complete cluster, approved by Manitoba Education and Training.

## 2017 Revisions to the Welding Technology Curriculum

During the 2016/2017 school year, a committee of welding technology teachers was struck to make revisions to the high school welding technology curriculum in order to reflect changes that were made to the Apprenticeship Manitoba *Welder Level 1* curriculum as part of the National Harmonization Initiative, which aligned trades training across Canada. This high school curriculum reflects the changes made as a result of the harmonization initiative.

## Role of Welders

Apprenticeship Manitoba describes the role of welders as follows:

A certified welder has the knowledge, ability and skills required to lay out, cut, prepare, repair, form, bend, install and join metals using a variety of welding equipment. Since the range of industrial items made of metal is extensive, welders must not only be versatile but also highly skilled. Welders are employed by boiler and heavy machinery manufacturers, metal fabrication shops, the aerospace industry, transportation companies and welding shops. (Apprenticeship Manitoba, n.d.)

## Career and Employment Opportunities in Welding Technology

A student who has completed the welding technology cluster can seek entry-level employment. Students can also continue into post-secondary studies or apprenticeship in a variety of areas related to building construction. Career paths include, but are not limited to, the following:

- welding entrepreneur
- oil field welder
- production welder
- pipeline welder
- boilermaker
- welding engineer
- welding inspector

- ironworker
- welding machine operator
- welding instructor
- aerospace technician
- underwater welder
- structural steel worker
- sales consultant
- materials engineer
- metallurgist
- sheet metal worker
- millwright
- custom fabrication and repair person

## Implementation of the Welding Technology Cluster

To receive a Senior Years Technology Education Program (SYTEP) diploma, a student must complete a minimum of eight departmentally developed courses from an approved TVE cluster, together with 16 compulsory credits and six optional credits.

Students must complete the eight mandatory courses from the Grades 10 to 12 Welding Technology curriculum to earn their SYTEP diploma and to meet the Level 1 apprenticeship training requirements for welders. Students do not need to complete the optional Grade 9 course in order to graduate from SYTEP or to meet the Level 1 apprenticeship requirements.

## Level 1 Apprenticeship for Welder

Students completing the welding technology cluster of courses have the opportunity to complete their Level 1 apprenticeship training to be a welder, since this cluster may only be taught by a journey person welder and the curriculum includes all of the objectives from *Welder Level 1* from Apprenticeship Manitoba. This document is available on the Apprenticeship Manitoba website at [www.gov.mb.ca/wd/apprenticeship/discover/mbrades/welder.html](http://www.gov.mb.ca/wd/apprenticeship/discover/mbrades/welder.html). (Apprenticeship Manitoba, 2015)

For more information on accreditation, see “Information for Instructors and Educators” on the Apprenticeship Manitoba website at [www.gov.mb.ca/wd/apprenticeship/generalinfo/instructoreducators.html](http://www.gov.mb.ca/wd/apprenticeship/generalinfo/instructoreducators.html).

In addition to including all of the Level 1 apprenticeship objectives for welder, the courses in this curriculum also include learning outcomes related to the following:

- metallurgy
- inspection and troubleshooting of welds
- design and fabrication of metal projects
- ethical and legal standards
- sustainability, including human sustainability and sustainable business practices
- evolution, technical progression, and emerging trends in welding technology

These outcomes were added so that students would have a more complete experience in the trade.

## The Multi-Course and Individual-Course Formats

This curriculum has been developed in two different formats. The **multi-course format** (found in this document) is comprised of either five columns (one course each in Grades 9 and 10, and three in Grade 11) or four columns (the four Grade 12 courses). It is found in this document, starting on page 15.

The **individual-course files** are made up of one course per file. Those nine files are found at [www.edu.gov.mb.ca/k12/cur/teched/sytep/welding/index.html](http://www.edu.gov.mb.ca/k12/cur/teched/sytep/welding/index.html).

The multi-course and individual-course formats have been developed for different reasons and serve different purposes. The most important difference is that the multi-course files (containing four or five columns) **do not contain all of the content**. Specifically, while they contain all of the specific learning outcomes (SLOs), they **do not contain all of the detailed content** associated with each SLO. That detailed content is found only in the individual-course files. Therefore, **teachers need to use the individual-course files**.

The multi-course format does not contain all of the content simply because there is not enough room for it. If it were to contain all of the content, some individual SLOs and their content would fill a narrow column for several pages, making them impossible to read.

However, teachers find the multi-course format very useful, because it allows them to compare the four or five courses listed there, and to see how students progress from one course to the next within each goal and general learning outcome.

The SLOs in this curriculum that correspond with the Apprenticeship Manitoba objectives from *Welder Level 1* have an alpha-numeric code at the end, which indicates the unit and objective from which they were taken.

Here is an example of an SLO and its content taken from *Welder Level 1*. 8377 Exploration of Welding Technology includes the following SLO 9.1.1.2:

9.1.1.2 "Identify safety and health requirements. (A1.1)"

The A1.1 code indicates that the SLO is Objective 1 from Unit A1 Trade Safety Awareness, found on page 1 of *Welder Level 1*: [www.gov.mb.ca/wd/apprenticeship/pdfpubs/pubs/discover/mb\\_trades/welder/welder\\_lev1.pdf](http://www.gov.mb.ca/wd/apprenticeship/pdfpubs/pubs/discover/mb_trades/welder/welder_lev1.pdf). The Level 1 document also includes the following essential content under A1.1:

- a. overview of *The Workplace Safety and Health Act*
  - rights and responsibilities of employees under the *Act*
  - rights and responsibilities of employers under the *Act*
  - rights and responsibilities of supervisors under the *Act*
- b. fourteen (14) regulations
- c. codes of practice
- d. guidelines
- e. right to refuse
  - explanation of right to refuse process
  - rights and responsibilities of employees
  - rights and responsibilities of employers
  - rights and responsibilities of supervisors under the *Act*

These details are a necessary part of this curriculum. So, when teaching this SLO, teachers must ensure that they are covering each point listed. Teachers also need to become familiar with the Welder documents from Apprenticeship Manitoba. These documents provide invaluable background to this curriculum, found at [www.gov.mb.ca/wd/apprenticeship/discover/mbtrades/welder.html](http://www.gov.mb.ca/wd/apprenticeship/discover/mbtrades/welder.html).

## Trade Safety Awareness Manual

Apprenticeship Manitoba has developed a Trade Safety Awareness Unit, the purpose of which is to increase student awareness of trade safety in the workplace. All students, including those in high school, studying a designated trade must complete this seven-hour unit.

The learning outcomes from the Trade Safety Awareness Unit are incorporated into GLO 1.2 of course 8378 Introduction to Welding 20S/20E/20M. The Trade Safety Awareness Unit's alphanumeric designations are located at the end of the applicable SLOs in this framework.

For example, the following SLO is found in 9194 Applied Welding Technology:

12D.2.7 Define workplace safety and health hazards.  
(TSA 7)

The TSA 7 code indicates that this SLO is taken from Apprenticeship Manitoba's Trade Safety Awareness Unit.

For more information, and to access the Trade Safety Awareness Unit and its tests and other resources, see "Information for Instructors and Educators" on the

Apprenticeship Manitoba website at [www.gov.mb.ca/wd/apprenticeship/generalinfo/instructoreducators.html](http://www.gov.mb.ca/wd/apprenticeship/generalinfo/instructoreducators.html).

Also see *Instructor Trade Safety Awareness Manual* at [www.gov.mb.ca/wd/apprenticeship/pdfpubs/pubs/general/trade\\_safety/instructor.pdf](http://www.gov.mb.ca/wd/apprenticeship/pdfpubs/pubs/general/trade_safety/instructor.pdf).

## Red Seal Resources

Because welder is a designated Red Seal trade across Canada, the Apprenticeship Manitoba curriculum is aligned with the Canada-wide Red Seal curriculum. High school welding technology teachers, as well as students working towards their Level 1 apprenticeship for welder, can find valuable resources in the *Welder* section of the Red Seal Program website at [www.red-seal.ca/trades/w.2ld.2r-eng.html](http://www.red-seal.ca/trades/w.2ld.2r-eng.html).

Among other resources, teachers and students can find sample examination questions used on Red Seal examinations.

## Qualifications of Welding Technology Teachers

Only vocationally certified teachers are allowed to teach TVE courses, including the ones in this welding technology cluster. Vocational certification includes three components:

1. **Trade Certification:** Welding technology teachers need to have personally experienced the apprenticeship and journeyman process so that they can share it with their students.

2. **Trade Experience:** Welding technology teachers need to have been employed as welders for at least six years (including their four-year apprenticeship). This will enable them to share their industry experience with students, which will, in turn, prepare them for working as welders.
3. **Technical-Vocational Teaching Certificate:** TVE teachers should have a technical vocational teaching certificate, obtained by completing Red River College's one-year Technical-Vocational Teacher Education Diploma program. For information about this program, see <http://me.rrc.mb.ca/Catalogue/ProgramInfo.aspx?RegionCode=WPG&ProgCode=TECVF-DP>.

Employing only vocationally certified teachers to teach TVE courses preserves the integrity of TVE programming by ensuring that teachers are able to share their first-hand experience working in welding technology, as well as their familiarity with industry certification and health and safety requirements. Students receive instruction from somebody who has been involved in that trade.

Apprenticeship Manitoba certifies TVE clusters offered in Manitoba schools only if they are taught by a vocationally certified teacher. Without a vocationally certified teacher, students' pathways to further study and careers are limited.

School boards risk significant liability if they employ non-vocationally certified teachers to teach TVE courses. Vocational certification confirms that a teacher has the requisite skills and knowledge to teach welding technology safely, reducing the risk of accident and injury.

For further information, see "Professional Certification: Technical Vocational Teacher" on the the department's website at [www.edu.gov.mb.ca/k12/cur/teched/docs/teacher-cert.pdf](http://www.edu.gov.mb.ca/k12/cur/teched/docs/teacher-cert.pdf).

## Comparison of Welding Technology with Industrial Arts Metalwork Technology

Like all TVE curricula, *Grades 9 to 12 Welding Technology: Manitoba Technical-Vocational Framework of Outcomes* has been developed to prepare high school students for a career in one specific trade. In this case, students will learn the knowledge, skills, and attitudes required to work as welders. It has not been developed as a general interest cluster of courses in metalwork technology. Schools interested in teaching such a course are invited to teach the industrial arts curricula, which can be found on the department's website at [www.edu.gov.mb.ca/k12/cur/teched/ind\\_arts.html](http://www.edu.gov.mb.ca/k12/cur/teched/ind_arts.html).

Although welding technology and industrial arts metalwork technology curricula share some common content, they have been developed for completely different purposes and have significant differences in content. The chart on the following page summarizes some of the differences between welding technology (as a TVE cluster of courses) and metalwork technology (as an industrial arts cluster of courses).

## Welding Technology and Industrial Arts Metalwork Technology Comparison Chart

Frequently Asked Questions	TVE Welding Technology	Industrial Arts Metalwork Technology
1. Is the purpose to facilitate students' transition to the welding trade?	Yes	No
2. Does the instruction try to emulate, as much as possible, a regular workplace?	Yes	No
3. Does the curriculum mandate employability skills such as punctuality and time management?	Yes	No
4. Is the teacher required to be a journeyperson welder?	Yes	No
5. Is the teacher required to have experience working as a welder?	Yes	No
6. Does the cluster prepare students for certification as a journeyperson welder?	Yes	No
7. Does the cluster focus on preparing students for entry-level employment as a welder after high school?	Yes	No
8. Is the teacher required to have a Manitoba General Teacher Certificate?	No	Yes
9. Is the teacher required to have a Manitoba Vocational Teacher Certificate?	Yes	No
10. Do schools require special permission from Manitoba Education and Training to offer a cluster of courses?	Yes	No
11. Do schools have to offer all of the courses in the cluster?	Yes	No
12. Do the clusters focus on <b>only one</b> trade or trained occupation?	Yes	No
13. Can schools offer hybrid clusters that are made up of courses from several clusters?	No	Yes
14. Will students receive a Senior Years Technology Education Program (SYTEP) Diploma when they complete a cluster of courses?	Yes	No

## Welding Technology Goals and General Learning Outcomes (GLOs)

The learning outcomes for each course in the welding technology cluster are based on the following curriculum goals and general learning outcomes (GLOs). **Please note that some welding technology courses do not address all of these goals and GLOs.**

---

**Goal 1:** Describe and apply appropriate **health and safety** practices.

**GLO 1.1:** Demonstrate adherence to **safe practices** and procedures for facilities, processes, tools, and equipment.

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Manual**.

---

**Goal 2:** Demonstrate an understanding of **metallurgy**.

**GLO 2.1:** Demonstrate an understanding of **metallurgy** as it applies to welding.

---

**Goal 3:** Demonstrate the **identification, operation, maintenance, and storage of equipment, materials, and consumable items**.

**GLO 3.1:** Demonstrate the **identification and operation** of equipment, materials, and consumable items.

**GLO 3.2:** Demonstrate the safe and appropriate **maintenance and storage** of equipment, materials, and consumable items.

**GLO 3.3:** Demonstrate an awareness of **hoisting, lifting, and rigging** procedures.

**GLO 3.4:** Demonstrate an awareness of **access equipment**.

---

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes.

**GLO 4.1:** Demonstrate **pre-welding** procedures.

**GLO 4.2:** Demonstrate **ability to weld**.

**GLO 4.3:** Perform **post-welding** procedures.

**GLO 4.4:** **Inspect** and **troubleshoot** welding projects.

**GLO 4.5:** Perform the **Manitoba Welder Practical Examinations**.

---

**Goal 5:** Demonstrate an understanding of **metal design and fabrication**.

**GLO 5.1:** **Design** metal projects.

**GLO 5.2:** **Fabricate** metal projects.

---

**Goal 6:** Describe and apply transferable **cross-curricular** knowledge and skills as they apply to welding (e.g., science, mathematics).

**GLO 6.1:** Apply knowledge and skills from the **language arts**.

**GLO 6.2:** Demonstrate knowledge of the **mathematics** skills related to the welding industry.

**GLO 6.3:** Demonstrate knowledge of **other subject areas** (i.e., information communication technology, English language arts, science, and physical education/health education) as they relate to the welding industry.

---

**Goal 7:** Follow the **ethical and legal standards** that pertain to the welding industry.

**GLO 7.1:** Demonstrate an awareness of the **ethical and legal standards** of welders.

---

**Goal 8:** Practise **employability skills** required in the welding industry.

**GLO 8.1:** Demonstrate **employability skills**.

---

**Goal 9:** Demonstrate an awareness of **sustainability** as it pertains to the welding industry.

**GLO 9.1:** Describe the impact of **human sustainability** on the health and well-being of welders.

**GLO 9.2:** Describe the **welding industry's sustainability practices** and **impact on the environment**.

**GLO 9.3:** Describe the **sustainable business practices** within the welding industry.

---

**Goal 10:** Demonstrate an understanding of the **structure** and **scope** of welding.

**GLO 10.1:** Describe the **scope** of welding.

**GLO 10.2:** Describe **apprenticeship, post-secondary, and employment opportunities** related to welding.

---

**Goal 11:** Demonstrate an understanding of the **evolution, technological progression, and emerging trends** in welding.

**GLO 11.1:** Demonstrate an understanding of the evolution, technological progression, and emerging trends in welding.

## Specific Learning Outcomes (SLOs)

*Grades 9 to 12 Welding Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes* identifies specific learning outcomes (SLOs) for use in all Manitoba schools teaching Grades 9 to 12 Welding Technology as part of the Senior Years Technology Education Program. SLO statements define what students are expected to achieve by the end of a course.

It is essential for students to learn and to demonstrate safety practices and employability skills; therefore, some SLOs related to health and safety, as well as to employability skills, are repeated in several courses.

Please note that SLOs are not identified for the goals and GLOs that are not addressed in a given course.

## Course Descriptions

8377 Exploration of Welding Technology 15S/15E/15M  
10S/10E/10M

This is an optional course intended for students wishing to explore welding technology. The emphasis is on hands-on introductory welding activities.

8378 Introduction to Welding Technology 20S/20E/20M

This course is intended to introduce students to a potential career in welding. The emphasis is on hands-on basic welding activities using GMAW (MIG), SMAW (ARC), and oxy-acetylene equipment.

8414 Metal Design/Fabrication & Oxy-Acetylene Procedures 30S/30E/30M

This course is intended for students who are considering a career in welding. The emphasis is on the design and fabrication of intermediate metal projects, as well as on oxy-acetylene procedures.

**8474 Basic GMAW (MIG) Procedures 30S/30E/30M**

This course is intended for students who are considering a career in welding. The emphasis is on hands-on basic flat GMAW (MIG) welding procedures.

**8486 Basic SMAW (ARC) Procedures 30S/30E/30M**

This course is intended for students who are considering a career in welding. The emphasis is on hands-on basic flat SMAW (ARC) welding procedures.

**8487 Advanced GMAW (MIG) Procedures 40S/40E/40M**

This course is intended for students who are intending to pursue a career in welding. The emphasis is on hands-on advanced positional GMAW (MIG) welding procedures.

**8488 Advanced SMAW (ARC) Procedures 40S/40E/40M**

This course is intended for students who are intending to pursue a career in welding. The emphasis is on hands-on advanced positional SMAW (ARC) welding procedures.

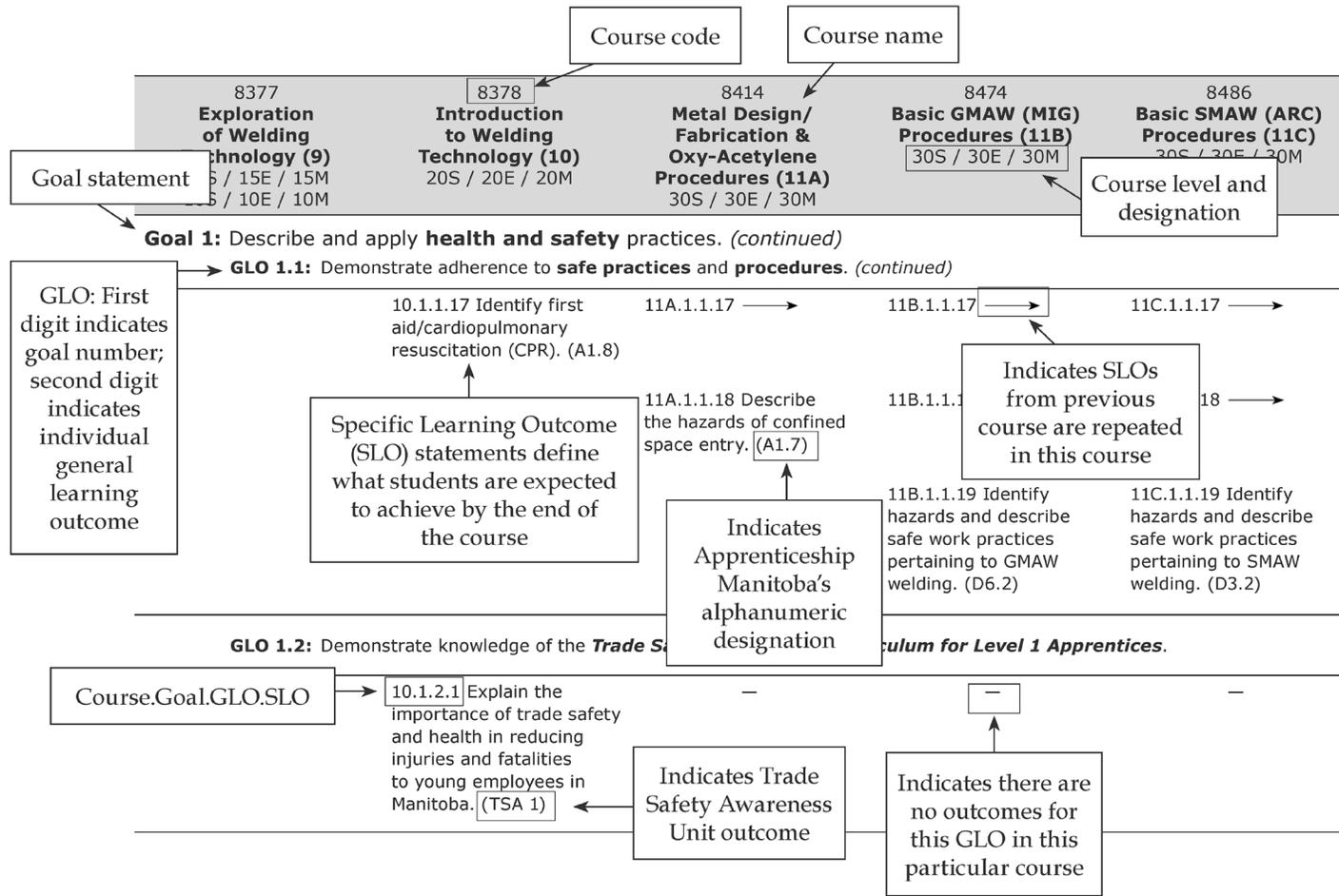
**8489 Advanced Metal Design/Fabrication 40S/40E/40M**

This course is intended for students who are intending to pursue a career in welding. The emphasis is on the design and fabrication of advanced metal projects.

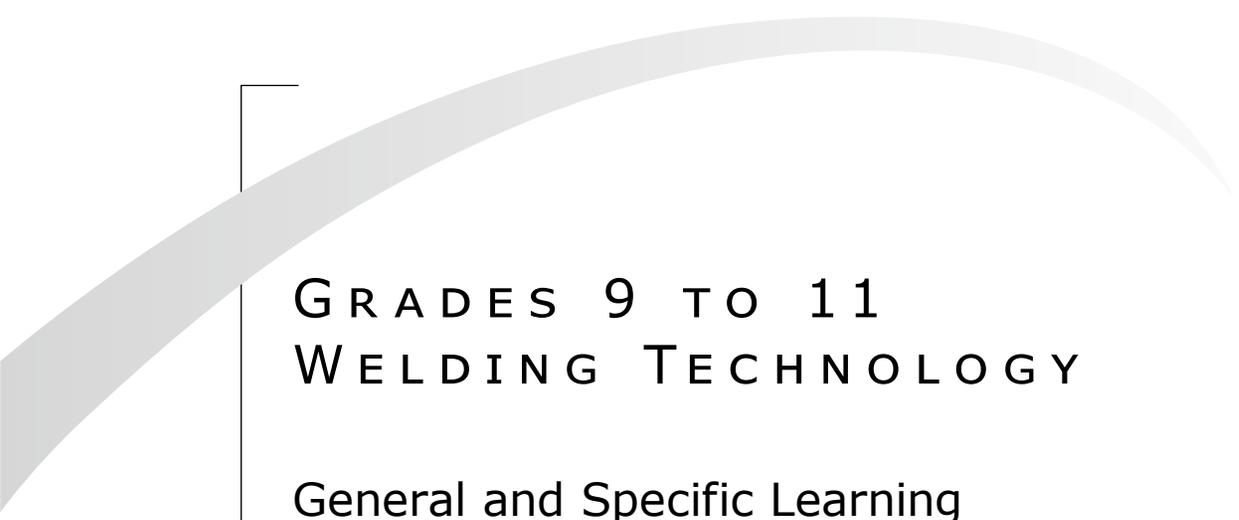
**8503 Applied Specialties  
and Qualifications 40S/40E/40M**

This course is intended for students who are intending to pursue a career in welding. The emphasis is on preparing for and performing the Manitoba Welder Practical Examination Structural Level 1 (Canadian Welding Bureau). Students are also introduced to hoisting, lifting, and rigging, as well as to access equipment.

# Guide to Reading Welding Technology Goals and Learning Outcomes







GRADES 9 TO 11  
WELDING TECHNOLOGY

General and Specific Learning  
Outcomes by Goal



## GRADES 9 TO 11 WELDING TECHNOLOGY: GENERAL AND SPECIFIC LEARNING OUTCOMES BY GOAL

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices.

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**.

9.1.1.1 Demonstrate adherence to safe practices and procedures for facilities, processes, tools, and equipment.	10.1.1.1 →	11A.1.1.1 →	11B.1.1.1 →	11C.1.1.1 →
9.1.1.2 Identify safety and health requirements. (A1.1)	10.1.1.2 →	11A.1.1.2 →	11B.1.1.2 →	11C.1.1.2 →
9.1.1.3 Identify personal protective equipment (PPE) and PPE procedures. (A1.2)	10.1.1.3 →	11A.1.1.3 →	11B.1.1.3 →	11C.1.1.3 →
9.1.1.4 Identify electrical safety. (A1.3)	10.1.1.4 →	11A.1.1.4 →	11B.1.1.4 →	11C.1.1.4 →
9.1.1.5 Identify fire safety. (A1.4)	10.1.1.5 →	11A.1.1.5 →	11B.1.1.5 →	11C.1.1.5 →

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**. *(continued)*

9.1.1.6 Identify ergonomics. (A1.5)	10.1.1.6 →	11A.1.1.6 →	11B.1.1.6 →	11C.1.1.6 →
9.1.1.7 Identify hazard recognition and control. (A1.6)	10.1.1.7 →	11A.1.1.7 →	11B.1.1.7 →	11C.1.1.7 →
9.1.1.8 Identify safety requirements as they apply to WHMIS. (A1.9)	10.1.1.8 →	11A.1.1.8 →	11B.1.1.8 →	11C.1.1.8 →
9.1.1.9 Describe the identification and control of specified hazards. (A1.10)	10.1.1.9 →	11A.1.1.9 →	11B.1.1.9 →	11C.1.1.9 →
9.1.1.10 Identify hazards and describe safe work practices pertaining to welding. (D1.3)	10.1.1.10 →	11A.1.1.10 →	11B.1.1.10 →	11C.1.1.10 →
9.1.1.11 Read, interpret, and communicate safety information (e.g., MSDS sheets, etc.).	10.1.1.11 →	11A.1.1.11 →	11B.1.1.11 →	11C.1.1.11 →

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**. *(continued)*

9.1.1.12 Safely store and handle compressed gas tanks.	10.1.1.12 →	11A.1.1.12 →	11B.1.1.12 →	11C.1.1.12 →
9.1.1.13 Demonstrate an awareness of hazards related to compressed gas.	10.1.1.13 →	11A.1.1.13 →	11B.1.1.13 →	11C.1.1.13 →
9.1.1.14 Demonstrate the safe use of compressed air.	10.1.1.14 →	11A.1.1.14 →	11B.1.1.14 →	11C.1.1.14 →
9.1.1.15 Demonstrate an understanding of and adherence to <i>Safe Work Procedures/Job Hazards Analysis</i> documents for each piece of equipment used.	10.1.1.15 →	11A.1.1.15 →	11B.1.1.15 →	11C.1.1.15 →
9.1.1.16 Demonstrate the safe use of a plasma arc cutter.	10.1.1.16 →	11A.1.1.16 →	11B.1.1.16 →	11C.1.1.16 →

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**. *(continued)*

	10.1.1.17 Identify first aid/cardiopulmonary resuscitation (CPR). (A1.8)	11A.1.1.17 →	11B.1.1.17 →	11C.1.1.17 →
		11A.1.1.18 Describe the hazards of confined space entry. (A1.7)	11B.1.1.18 →	11C.1.1.18 →
			11B.1.1.19 Identify hazards and describe safe work practices pertaining to GMAW welding. (D6.2)	11C.1.1.19 Identify hazards and describe safe work practices pertaining to SMAW welding. (D3.2)

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Curriculum for Level 1 Apprentices**.

—	10.1.2.1 Explain the importance of trade safety and health in reducing injuries and fatalities to young employees in Manitoba. (TSA 1)	—	—	—
---	----------------------------------------------------------------------------------------------------------------------------------------	---	---	---

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Curriculum for Level 1 Apprentices**. *(continued)*

10.1.2.2 Describe the rights and responsibilities of employees, employers, and supervisors under the *Workplace Safety and Health Act*. (TSA 2)

10.1.2.3 Describe the steps to use in the Right to Refuse process. (TSA 3)

10.1.2.4 Explain how and where to find information on workplace safety and health. (TSA 4)

10.1.2.5 Demonstrate how to handle a potentially dangerous work situation. (TSA 5)

10.1.2.6 Explain the S.A.F.E. acronym. (TSA 6)

10.1.2.7 Define workplace safety and health hazards. (TSA 7)

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Curriculum for Level 1 Apprentices**. *(continued)*

10.1.2.8 Give examples of trade-specific workplace safety and health hazards. (TSA 8)

10.1.2.9 Give examples of five types of safety and health hazards. (TSA 9)

10.1.2.10 Define workplace safety and health risks. (TSA 10)

10.1.2.11 Give examples of trade-specific workplace safety and health risks. (TSA 11)

10.1.2.12 Explain the principles of hazard recognition and control as they apply to welding. (TSA 12)

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Curriculum for Level 1 Apprentices**. *(continued)*

10.1.2.13 Explain the Workplace Hazardous Material Information System (WHMIS). (TSA 13)

10.1.2.14 Match the WHMIS hazardous materials symbols and their meanings. (TSA 14)

10.1.2.15 Describe the importance of the Material Safety Data Sheets (MSDS). (TSA 15)

10.1.2.16 Describe the importance of using personal protective equipment (PPE). (TSA 16)

10.1.2.17 Demonstrate proper selection and use of a variety of personal protective equipment and fall protection systems. (TSA 17)

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
--------------------------------------------------------------------------------------------	---------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------	---------------------------------------------------------------------	---------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Curriculum for Level 1 Apprentices**. *(continued)*

10.1.2.18 Outline the safety principles for working on and around electrical equipment. (TSA 18)

10.1.2.19 Outline workplace fire safety principles. (TSA 19)

10.1.2.20 Identify the hazards in confined spaces and the preparation needed to work in a confined space. (TSA 20)

**Goal 2:** Demonstrate an understanding of **metallurgy**.

**GLO 2.1:** Demonstrate an understanding of **metallurgy** as it applies to welding.

9.2.1.1 Demonstrate an understanding of metallurgy as it applies to welding.

10.2.1.1 →

11A.2.1.1 Demonstrate an understanding of metallurgy as it applies to metal design/ fabrication and oxy-acetylene welding.

11B.2.1.1 Demonstrate an understanding of metallurgy as it applies to basic GMAW welding.

11C.2.1.1 Demonstrate an understanding of metallurgy as it applies to basic SMAW welding.

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 2:** Demonstrate an understanding of **metallurgy**. *(continued)*

**GLO 2.1:** Demonstrate an understanding of **metallurgy** as it applies to welding. *(continued)*

<p>9.2.1.2 Select appropriate filler materials to suit base metal.</p>	<p>10.2.1.2 →</p> <p>10.2.1.3 Demonstrate an awareness of the tendency for metals to distort.</p> <p>10.2.1.4 Distinguish between ferrous and non-ferrous metals.</p> <p>10.2.1.5 Demonstrate an awareness of different rates of thermal conductivity found in various metals.</p> <p>10.2.1.6 Distinguish between stainless steel, mild steel, and aluminum.</p>	<p>11A.2.1.2 →</p> <p>11A.2.1.3 Utilize distortion-prevention strategies while welding.</p>	<p>11A.2.1.2 →</p>	<p>11C.2.1.2 →</p> <p>11C.2.1.3 Select appropriate electrode to suit base metal.</p>
------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------	--------------------	--------------------------------------------------------------------------------------

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.**

**GLO 3.1:** Demonstrate the **identification** and **operation** of equipment, materials, and consumable items.

9.3.1.1 Demonstrate the operation and handling of equipment, tools, materials, products, and consumable items.	10.3.1.1 →	11A.3.1.1 →	11B.3.1.1 →	11C.3.1.1 →
9.3.1.2 Identify types of hand tools, and describe their applications and procedures for use. (A3.2)	10.3.1.2 →	11A.3.1.2 Adjust oxy-acetylene equipment for different processes, materials, and thicknesses.	11B.3.1.2 Identify the considerations when selecting consumables and determining equipment set-up for performing GMAW fillet welds in all positions. (D6.3)	11C.3.1.2 Identify SMAW welding equipment, consumables, and accessories, and describe their applications. (D3.4)
9.3.1.3 Identify types of power tools, and describe their applications and procedures for use. (A3.4)	10.3.1.3 →	11A.3.1.3 Troubleshoot equipment settings after welding.	11B.3.1.3 Identify GMAW equipment maintenance and troubleshooting.	11C.3.1.3 Identify the considerations when selecting consumables and determining equipment set-up for performing SMAW fillet welds in all positions. (D3.a.3)

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.** *(continued)*

**GLO 3.1:** Demonstrate the **identification** and **operation** of equipment, materials, and consumable items. *(continued)*

			11B.3.1.4 Set up and operate GMAW equipment.	11C.3.1.4 Perform the procedures used to set up and adjust SMAW welding equipment. (D3.a.5)
--	--	--	----------------------------------------------	---------------------------------------------------------------------------------------------

**GLO 3.2:** Demonstrate the safe and appropriate **maintenance** and **storage** of equipment, materials, and consumable items.

9.3.2.1 Practise the appropriate cleaning maintenance, and storage of welding equipment, tools, materials, products, and consumable items.	10.3.2.1 →	11A.3.2.1 Follow safe procedures for cleaning and storing oxy-acetylene equipment.	11B.3.2.1 Practise the appropriate cleaning, maintenance, and storage of GMAW equipment, tools, materials, products, and consumable items.	11C.3.2.1 Practise the appropriate cleaning, maintenance, and storage of SMAW equipment, tools, materials, products, and consumable items.
	10.3.2.2 Clean, maintain, and store plasma cutters and consumables.	11A.3.2.2 Define terminology associated with stationary machinery. (A3.a.1)		11C.3.2.2 Demonstrate the appropriate storage of low hydrogen electrodes.

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance, and storage** of **equipment, materials, and consumable items.** *(continued)*

**GLO 3.2:** Demonstrate the safe and appropriate **maintenance and storage** of equipment, materials, and consumable items. *(continued)*

	10.3.2.3 Describe the procedures used to inspect, maintain, and store hand tools. (A3.3)	11A.3.2.3 Identify hazards and describe safe work practices pertaining to stationary machinery. (A3.a.2)		11C.3.2.3 Describe the procedures used to inspect and maintain SMAW welding equipment. (D3.8)
	10.3.2.4 Identify power tool attachments and consumables, and describe their applications and procedures for use. (A3.5)	11A.3.2.4 Identify types of stationary machinery, and describe their characteristics and applications. (A3.a.3)		11C.3.2.4 Identify the requirements and describe the procedures to store consumables used for SMAW fillet welds on low carbon steel. (D3.a.4)
	10.3.2.5 Describe the procedures used to inspect, maintain, and store power tools. (A3.6)	11A.3.2.5 Perform the procedures used to set up and operate stationary machinery. (A3.a.5)		
	10.3.2.6 Identify types of layout and measuring tools and equipment, and describe their applications and procedures for use. (A3.7)	11A.3.2.6 Perform the procedures used to inspect and maintain stationary machinery. (A3.a.6)		

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.** *(continued)*

**GLO 3.2:** Demonstrate the safe and appropriate **maintenance** and **storage** of equipment, materials, and consumable items. *(continued)*

10.3.2.7 Describe the procedures used to inspect, maintain, and store layout and measuring tools and equipment. (A3.8)

10.3.2.8 Describe the procedures used to inspect and maintain oxy-fuel equipment. (C3.7)

10.3.2.9 Perform the procedures used to inspect, maintain, and troubleshoot OFW welding equipment. (C3.8, C3.9)

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes.

**GLO 4.1:** Demonstrate **pre-welding** procedures.

9.4.1.1 Identify GMAW welding processes, and describe their characteristics and applications.	10.4.1.1 Identify SMAW and GMAW welding processes, and describe their characteristics and applications. (D1.5.a & b)	11A.4.1.1 Prepare material for metal fabrication and oxy-acetylene procedures.	11B.4.1.1 Identify GMAW welding processes, and describe their characteristics and applications. (D1.5.b)	11C.4.1.1 Identify SMAW welding processes, and describe their characteristics and applications. (D1.5.a)
9.4.1.2 Prepare material and equipment for welding.	10.4.1.2 →	11A.4.1.2 Identify types of power sources for welding equipment, and describe their applications and limitations. (D1.6)	11B.4.1.2 Prepare material for basic GMAW procedures.	11C.4.1.2 Prepare material for basic SMAW welding.
	10.4.1.3 Identify types of flames, and describe their application and the procedures for flame adjustment. (C3.5)			11C.4.1.3 Describe the procedures used to set up and adjust SMAW welding equipment. (D3.5)
	10.4.1.4 Perform the procedures used to set up, adjust, and shut down oxy-fuel equipment. (C3.6)			

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.2:** Demonstrate **ability to weld**.

9.4.2.1 Perform the procedures and techniques used to deposit a weld bead using GMAW welding equipment. (D6.9)	10.4.2.1 Identify GMAW welding.	11A.4.2.1 Perform the procedures used to braze/weld using oxy-fuel equipment. (C3.12)	11B.4.2.1 Define terminology associated with FCAW welding. (D11.1)	11C.4.2.1 Identify basic joint and weld types.
9.4.2.2 Identify hazards and describe safe work practices pertaining to oxy-fuel cutting, gouging, and welding. (C3.2)	10.4.2.2 Perform the procedures and techniques used to deposit a weld bead using GMAW welding equipment. (D6.9)	11A.4.2.2 Sequence welds to minimize distortion, etc.	11B.4.2.2 Perform GMAW welds on mild steel.	11C.4.2.2 Describe the procedures and techniques used to deposit a weld bead using SMAW welding equipment. (D3.7)
9.4.2.3 Identify oxy-fuel equipment and accessories, and describe their applications and limitations. (C3.4)	10.4.2.3 Identify hazards and describe safe work practices pertaining to oxy-fuel cutting, gouging, and welding. (C3.2)	11A.4.2.3 Perform 90° cuts using oxy-acetylene.	11B.4.2.3 Perform FCAW welds on mild steel.	11C.4.2.3 Perform surface welds in the flat position.
9.4.2.4 Set up, operate, and shut down oxy-fuel equipment. (C3.13)	10.4.2.4 Identify oxy-fuel equipment and accessories, and describe their applications and limitations. (C3.4)	11A.4.2.4 Perform circular cuts using oxy-acetylene.	11B.4.2.4 Perform combined GMAW and FCAW welds on mild steel.	11C.4.2.4 Perform 1F welds using SMAW.

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.2:** Demonstrate **ability to weld**. *(continued)*

10.4.2.5 Set up, operate, and shut down oxy-fuel equipment. (C3.13)	11A.4.2.5 Perform bevelled cuts using oxy-acetylene.	11B.4.2.5 Perform MCAW welds on mild steel.	11C.4.2.5 Perform the procedures used to perform fillet welds on low carbon steel in all positions using the SMAW process. (D3.a.6)
10.4.2.6 Perform SMAW welds.	11A.4.2.6 Identify welding positions and describe their applications. (D1.9)	11B.4.2.6 Identify GMAW welding equipment, consumables, and accessories, and describe their applications. (D6.4)	
10.4.2.7 Identify the types of beads, and describe their characteristics and applications. (D1.7)	11A.4.2.7 Perform cuts using a plasma arc cutter.	11B.4.2.7 Describe the procedures used to assemble and disassemble GMAW welding equipment. (D6.5)	
10.4.2.8 Identify types of welds, and describe their characteristics and applications. (D1.8)		11B.4.2.8 Describe the procedures used to establish and maintain an arc using GMAW welding equipment. (D6.6)	

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.2:** Demonstrate **ability to weld**. *(continued)*

10.4.2.9 Describe the procedures used to strike and maintain an arc using SMAW welding equipment. (D3.6, D3.9)

10.4.2.10 Perform the procedures used to weld using oxy-fuel equipment. (C3.11)

11B.4.2.9 Describe the procedures and techniques used to deposit a weld bead using GMAW welding equipment. (D6.8)

**GLO 4.3:** Perform **post-welding** procedures.

9.4.3.1 Perform cleaning procedures (i.e., chipping, grinding).

10.4.3.1 →

11A.4.3.1 Perform cleaning procedures (i.e., chipping, grinding) on a project.

11B.4.3.1 Perform cleaning procedures (i.e., chipping, grinding) on GMAW welds.

11C.4.3.1 Perform cleaning procedures (i.e., chipping, grinding) on SMAW welds.

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.4: Inspect and troubleshoot** welding projects.

9.4.4.1 Demonstrate an awareness of weld defects.	10.4.4.1 Inspect and troubleshoot welding projects.  10.4.4.2 Perform the procedures used to prevent and correct weld faults. (D3.a.7)	11A.4.4.1 →  11A.4.4.2 Describe the causes of weld defects found in intermediate projects and the methods for their prevention.	11B.4.4.1 →	11C.4.4.1 →
---------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------	-------------	-------------

**Goal 5:** Demonstrate an understanding of **metal design and fabrication**.

**GLO 5.1: Design** metal projects.

9.5.1.1 Demonstrate an awareness of design in welding.	10.5.1.1 Read, interpret, and communicate shop sketches.  10.5.1.2 Select appropriate materials.  10.5.1.3 Measure and lay out material.	11A.5.1.1 Interpret information pertaining to welding on drawings. (D1.2)  11A.5.1.2 Perform a basic sketch of a proposed project.  11A.5.1.3 Select appropriate material for project requirements.	—	—
--------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---	---

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 5:** Demonstrate an understanding of **metal design and fabrication.** *(continued)*

**GLO 5.1: Design** metal projects. *(continued)*

11A.5.1.4 Measure and lay out material.

**GLO 5.2: Fabricate** metal projects.

9.5.2.1 Cut material for an introductory project following broad measurements, angles, etc.	10.5.2.1 →	11A.5.2.1 Cut material for intermediate project, following specific measurements, angles, etc.	11B.5.2.1 →	11C.5.2.1 →
9.5.2.2 Perform basic material preparation and fit-up.	10.5.2.2 →	11A.5.2.2 Perform accurate material preparation and fit-up for intermediate project.	11B.5.2.2 →	11C.5.2.2 →
9.5.2.3 Tack material.	10.5.2.3 Tack material using GMAW and SMAW procedures.	11A.5.2.3 Tack material for project.		

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 6:** Describe and apply the transferable **cross-curricular** knowledge and skills.

**GLO 6.1:** Apply knowledge and skills from the **language arts**.

9.6.1.1 Define terminology associated with GMAW welding. (D6.1)	10.6.1.1 →	11A.6.1.1 →	—	11C.6.1.1 Define terminology associated with SMAW fillet welds. (D3.a.1)
9.6.1.2 Define terminology associated with oxy-fuel cutting, gouging, and welding. (C3.1)	10.6.1.2 →			11C.6.1.2 Interpret information pertaining to SMAW fillet welds found on drawings and specifications. (D3.a.2)
	10.6.1.3 Define terminology associated with welding. (D1.1)			11C.6.1.3 Define terminology associated with SMAW welding. (D3.1)
	10.6.1.4 Define terminology associated with SMAW welding. (D3.1)			

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 6:** Describe and apply the transferable **cross-curricular** knowledge and skills. *(continued)*

**GLO 6.2:** Demonstrate the **mathematics** skills related to welding.

9.6.2.1 Demonstrate an understanding of basic measurement skills.	10.6.2.1 Demonstrate basic measurement skills.	11A.6.2.1 Accurately calculate and measure parts and angles for welding projects.	11B.6.2.1 Solve problems involving fractions. (B3.1)	11C.6.2.1 Read, interpret, and communicate welding terminology.
	10.6.2.2 Calculate perimeter and area.	11A.6.2.2 Read, interpret, and communicate welding terminology.	11B.6.2.2 Solve problems involving decimals. (B3.2)	11C.6.2.2 Read, interpret, and communicate information found on welding materials (e.g., filler rods, electrodes, etc.).
	10.6.2.3 Calculate volume of cylinders.	11A.6.2.3 Read, interpret, and communicate information found on welding materials (e.g., filler rods, electrodes, etc.).	11B.6.2.3 Solve problems involving metric and imperial measure. (B3.4)	
	10.6.2.4 Read, interpret, and communicate welding terminology.		11B.6.2.4 Read, interpret, and communicate welding terminology.	
	10.6.2.5 Read, interpret, and communicate information found on welding materials (e.g., filler rods, electrodes, etc.).		11B.6.2.5 Read, interpret, and communicate information found on welding materials (e.g., filler rods, electrodes, etc.).	

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 6:** Describe and apply the transferable **cross-curricular** knowledge and skills. *(continued)*

**GLO 6.3:** Demonstrate knowledge of **other subject areas**.

—	10.6.3.1 Demonstrate an understanding of the uses of electricity in welding (i.e., conductivity, current, voltage, amperage, polarity, AC versus DC).	11A.6.3.1 →	11B.6.3.1 →	11C.6.3.1 →
	10.6.3.2 Demonstrate an understanding of the states of matter.	11A.6.3.2 →	11B.6.3.2 →	11C.6.3.2 →
	10.6.3.3 Demonstrate an awareness of welding symbols.	11A.6.3.3 →	11B.6.3.3 →	11C.6.3.3 →
	10.6.3.4 Demonstrate the use of information and communication technology in order to research topics in welding.	11A.6.3.4 Demonstrate an awareness of CNC technology.		
		11A.6.3.5 Identify types of communication devices and describe their applications. (A1.a.2)		

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 7:** Follow the **ethical** and **legal standards** that pertain to the welding industry.

**GLO 7.1:** Demonstrate an awareness of the **ethical** and **legal expectations** of welders.

—	<p>10.7.1.1 Demonstrate an awareness of the ethical and legal standards.</p> <p>10.7.1.2 Demonstrate an understanding of the ethical and legal expectations of welders.</p> <p>10.7.1.3 Interpret regulations pertaining to tools and equipment. (A3.1)</p> <p>10.7.1.4 Identify and interpret codes and regulations pertaining to oxy-fuel cutting, gouging, and welding equipment and operations. (C3.3)</p>	<p>11A.7.1.1 Demonstrate an understanding of the ethical concerns in the welding industry as they relate to safety.</p>	<p>11B.7.1.1 Demonstrate an understanding of the relationship between ethics and employability skills such as creating a respectful workplace and demonstrating a strong work ethic.</p>	<p>11C.7.1.1 Demonstrate an understanding of the legal requirements related to specialized welding, such as the welding of pressure vessels and steering components.</p>
---	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 8: Demonstrate employability skills.**

**GLO 8.1: Demonstrate employability skills.**

9.8.1.1 Demonstrate problem-solving skills.	10.8.1.1 →	11A.8.1.1 →	11B.8.1.1 →	11C.8.1.1 →
9.8.1.2 Demonstrate regular attendance and punctuality.	10.8.1.2 →	11A.8.1.2 →	11B.8.1.2 →	11C.8.1.2 →
9.8.1.3 Demonstrate accountability for their actions.	10.8.1.3 →	11A.8.1.3 →	11B.8.1.3 →	11C.8.1.3 →
9.8.1.4 Demonstrate adaptability and effort.	10.8.1.4 →	11A.8.1.4 →	11B.8.1.4 →	11C.8.1.4 →
9.8.1.5 Demonstrate the ability to accept and follow direction and feedback.	10.8.1.5 →	11A.8.1.5 →	11B.8.1.5 →	11C.8.1.5 →
9.8.1.6 Demonstrate teamwork skills.	10.8.1.6 →	11A.8.1.6 →	11B.8.1.6 →	11C.8.1.6 →
9.8.1.7 Demonstrate the ability to stay on task and effectively use time.	10.8.1.7 →	11A.8.1.7 →	11B.8.1.7 →	11C.8.1.7 →

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 8:** Demonstrate **employability skills**. *(continued)*

**GLO 8.1:** Demonstrate **employability skills**. *(continued)*

9.8.1.8 Describe effective verbal and non-verbal communication. (A1.a.1)	10.8.1.8 →	11A.8.1.8 →	11B.8.1.8 →	11C.8.1.8 →
		11A.8.1.9 Demonstrate critical thinking skills.	11B.8.1.9 →	11C.8.1.9 →

**Goal 9:** Demonstrate an awareness of **sustainability** as it pertains to the welding industry.

**GLO 9.1:** Describe the impact of **human sustainability** on the health and well-being of welders.

9.9.1.1 Demonstrate an understanding of sustainability as it relates to human health and well-being.	10.9.1.1 →	11A.9.1.1 Appreciate the impact of sustainable practices on human health and well-being.	11B.9.1.1 Identify sustainability factors that influence human health and well-being for welders.	11C.9.1.1 Demonstrate an awareness of factors related to the sustainability of the welder's working conditions, including working hours, out-of-town travel, and shift work.
		11A.9.1.2 Demonstrate an understanding of the importance of working conditions on human sustainability.	11B.9.1.2 Demonstrate an understanding of sustainability factors in the welding industry that affect human health and well-being.	

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
--------------------------------------------------------------------------------------------	---------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------	---------------------------------------------------------------------	---------------------------------------------------------------------

**Goal 9:** Demonstrate an awareness of **sustainability** as it pertains to the welding industry. *(continued)*

**GLO 9.2:** Describe the welding industry's **sustainability practices** and impact on the environment.

9.9.2.1 Identify the welding industry's sustainability practices and impact on the environment.	10.9.2.1 Demonstrate an understanding of the importance of recycling metal used in the welding industry.	11A.9.2.1 Demonstrate an understanding of the importance of reducing waste in the welding industry.	11B.9.2.1 Demonstrate an understanding of the appropriate reuse of materials in welding.	—
-------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------	---

**GLO 9.3:** Describe the **sustainable business practices** within the welding industry.

9.9.3.1 Identify industries where welding is used.	10.9.3.1 Identify which industries hire welders.	11A.9.3.1 Demonstrate an awareness of the influence of welding on the local economy.	11B.9.3.1 Demonstrate an awareness of the importance of working conditions on employee retention.	—
----------------------------------------------------	--------------------------------------------------	--------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------	---

**Goal 10:** Demonstrate an understanding of the **structure** and **scope** of welding.

**GLO 10.1:** Describe the **scope** of welding.

—	10.10.1.1 Describe the structure and scope of the modern welding trade. (A2.1)	—	—	—
---	--------------------------------------------------------------------------------	---	---	---

8377 <b>Exploration of Welding Technology (9)</b> 15S / 15E / 15M 10S / 10E / 10M	8378 <b>Introduction to Welding Technology (10)</b> 20S / 20E / 20M	8414 <b>Metal Design/ Fabrication &amp; Oxy-Acetylene Procedures (11A)</b> 30S / 30E / 30M	8474 <b>Basic GMAW (MIG) Procedures (11B)</b> 30S / 30E / 30M	8486 <b>Basic SMAW (ARC) Procedures (11C)</b> 30S / 30E / 30M
----------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------	-------------------------------------------------------------------------

**Goal 10:** Demonstrate an understanding of the **structure** and **scope** of welding. *(continued)*

**GLO 10.2:** Describe **apprenticeship, post-secondary, and employment opportunities.**

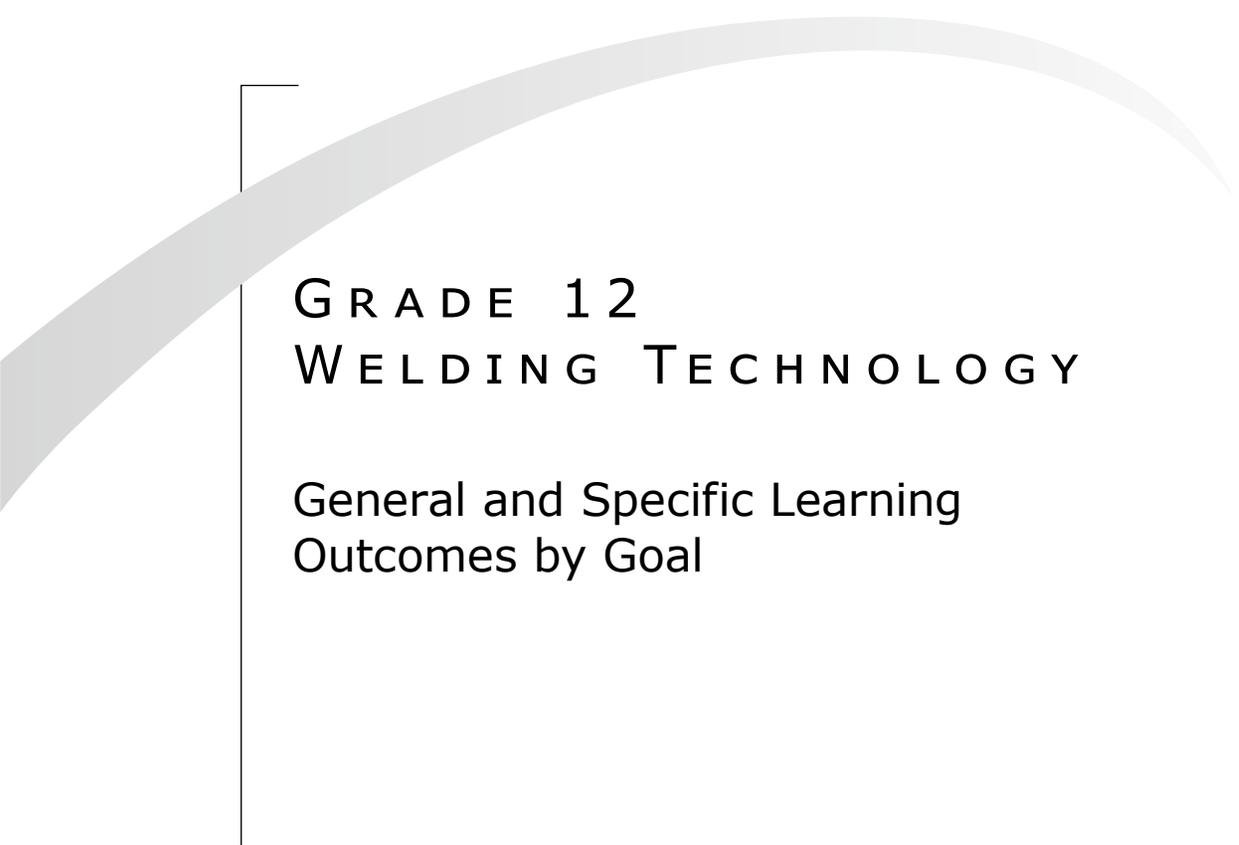
—	10.10.2.1 Demonstrate an awareness of career opportunities in welding.	11A.10.2.1 Demonstrate an awareness of training and career opportunities in metal design and fabrication.	11B.10.2.1 Demonstrate an awareness of career opportunities in GMAW welding.	11C.10.2.1 Demonstrate an awareness of career opportunities in SMAW welding.
	10.10.2.2 Demonstrate an awareness of the benefits of certification in welding.		11B.10.2.2 Demonstrate an awareness of career opportunities in robotic GMAW welding.	
	10.10.2.3 Demonstrate an awareness of apprenticeship.			

**Goal 11:** Demonstrate an understanding of the **evolution, technological progression, and emerging trends** in welding.

**GLO 11.1:** Demonstrate an understanding of the **evolution, technological progression, and emerging trends** in welding.

9.11.1.1 Demonstrate an awareness of the evolution of welding, including its technological progression and emerging trends.	10.11.1.1 Research the evolution of welding, including its technological progression and emerging trends.	11A.11.1.1 Demonstrate an awareness of the evolution of oxy-acetylene welding.	11B.11.1.1 Research the use of robotics in GMAW welding.	11C.11.1.1 Demonstrate an awareness of emerging trends in metal fusion.
-----------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------	----------------------------------------------------------	-------------------------------------------------------------------------





GRADE 12  
WELDING TECHNOLOGY

General and Specific Learning  
Outcomes by Goal



# GRADE 12 WELDING TECHNOLOGY: GENERAL AND SPECIFIC LEARNING OUTCOMES BY GOAL

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices.

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**.

12A.1.1.1 Demonstrate adherence to safe practices and procedures for facilities, processes, tools, and equipment.	12B.1.1.1 →	12C.1.1.1 →	12D.1.1.1 →
12A.1.1.2 Identify safety and health requirements. (A1.1)	12B.1.1.2 →	12C.1.1.2 →	12D.1.1.2 →
12A.1.1.3 Identify personal protective equipment (PPE) and PPE procedures. (A1.2)	12B.1.1.3 →	12C.1.1.3 →	12D.1.1.3 →
12A.1.1.4 Identify electrical safety. (A1.3)	12B.1.1.4 →	12C.1.1.4 →	12D.1.1.4 →
12A.1.1.5 Identify fire safety. (A1.4)	12B.1.1.5 →	12C.1.1.5 →	12D.1.1.5 →
12A.1.1.6 Identify ergonomics. (A1.5)	12B.1.1.6 →	12C.1.1.6 →	12D.1.1.6 →

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**. *(continued)*

12A.1.1.7 Identify hazard recognition and control. (A1.6)	12B.1.1.7 →	12C.1.1.7 →	12D.1.1.7 →
12A.1.1.8 Describe the hazards of confined space entry. (A1.7)	12B.1.1.8 →	12C.1.1.8 →	12D.1.1.8 →
12A.1.1.9 Identify first aid/ cardiopulmonary resuscitation (CPR). (A1.8)	12B.1.1.9 →	12C.1.1.9 →	12D.1.1.9 →
12A.1.1.10 Identify safety requirements as they apply to WHMIS. (A1.9)	12B.1.1.10 →	12C.1.1.10 →	12D.1.1.10 →
12A.1.1.11 Describe the identification and control of specified hazards. (A1.10)	12B.1.1.11 →	12C.1.1.11 →	12D.1.1.11 →
12A.1.1.12 Read, interpret, and communicate safety information (e.g., MSDS, etc.).	12B.1.1.12 →	12C.1.1.12 →	12D.1.1.12 →
12A.1.1.13 Safely store and handle compressed gas tanks.	12B.1.1.13 →	12C.1.1.13 →	12D.1.1.13 →
12A.1.1.14 Discuss hazards related to compressed gas.	12B.1.1.14 →	12C.1.1.14 →	12D.1.1.14 →

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**. *(continued)*

12A.1.1.15 Demonstrate the safe use of compressed air.	12B.1.1.15 →	12C.1.1.15 →	12D.1.1.15 →
12A.1.1.16 Demonstrate an understanding of and adherence to <i>Safe Work Procedures Job Hazards Analysis</i> documents for each piece of equipment that is used.	12B.1.1.16 →	12C.1.1.16 →	12D.1.1.16 →
12A.1.1.17 Identify hazards and describe safe work practices pertaining to GMAW welding. (D6.2)	12B.1.1.17 →	12C.1.1.17 →	12D.1.1.17 →
12A.1.1.18 Demonstrate an understanding of the worker's responsibility to refuse unsafe work.	12B.1.1.18 →	12C.1.1.18 →	12D.1.1.18 →
	12B.1.1.19 Identify hazards and describe safe work practices pertaining to SMAW welding. (D3.2)	12C.1.1.19 →	12D.1.1.19 →

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 1:** Describe and apply **health and safety** practices. *(continued)*

**GLO 1.1:** Demonstrate adherence to **safe practices** and **procedures**. *(continued)*

12D.1.1.20 Identify hazards and describe safe work practices pertaining to FCAW welding. (D11.2)

12D.1.1.21 Identify hazards and describe safe work practices pertaining to MCAW welding. (D11.b.2)

**Goal 2:** Demonstrate an understanding of **metallurgy**.

**GLO 2.1:** Demonstrate an understanding of **metallurgy** as it applies to welding.

12A.2.1.1 Select appropriate filler materials to suit base metal.

12B.2.1.1 →

12C.2.1.1 →

12D.2.1.1 →

12A.2.1.2 Demonstrate an understanding of various metals.

12B.2.1.2 Demonstrate an awareness of carbon content in different types of steel.

12C.2.1.2 Demonstrate an awareness of physical and mechanical properties of different types of steel.

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.**

**GLO 3.1:** Demonstrate the **identification** and **operation** of equipment, materials, and consumable items.

<p>12A.3.1.1 Demonstrate the safe and appropriate operation and handling of equipment, tools, materials, products, and consumable items used in advanced GMAW welding processes and procedures.</p> <p>12A.3.1.2 Identify GMAW welding equipment, consumables, and accessories, and describe their applications. (D6.a.4)</p>	<p>12B.3.1.1 Demonstrate the safe and appropriate operation and handling of equipment, tools, materials, products, and consumable items used in advanced SMAW welding processes and procedures.</p>	<p>12C.3.1.1 Demonstrate the safe and appropriate operation and handling of equipment, tools, materials, products, and consumable items used in advanced metal design/fabrication.</p>	<p>12D.3.1.1 Demonstrate the safe and appropriate operation and handling of equipment, tools, materials, products, and consumable items used in advanced specialties and qualifications.</p> <p>12D.3.1.2 Identify FCAW welding equipment, consumables, and accessories, and describe their applications. (D11.4)</p> <p>12D.3.1.3 Identify MCAW welding equipment, consumables, and accessories, and describe their applications. (D11.b.4)</p>
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance, and storage** of **equipment, materials, and consumable items.** *(continued)*

**GLO 3.2:** Demonstrate the safe and appropriate **maintenance** and **storage** of equipment, materials, and consumable items.

<p>12A.3.2.1 Practise the cleaning, maintenance, and storage of GMAW equipment, tools, materials, products, and consumable items.</p>	<p>12B.3.2.1 Practise the cleaning, maintenance, and storage of SMAW equipment, tools, materials, products, and consumable items.</p>	<p>12C.3.2.1 Practise the cleaning, maintenance, and storage of equipment, tools, materials, products, and consumable items used in advanced metal design/fabrication.</p>	<p>12D.3.2.1 Practise the cleaning, maintenance, and storage of equipment, tools, materials, products, and consumable items used in applied specialties and qualifications.</p>
<p>12A.3.2.2 Describe the requirements and describe the procedures to store consumables used for GMAW fillet welds on low carbon steel plate. (D6.a.5)</p>	<p>12B.3.2.2 Demonstrate the appropriate storage of low hydrogen electrodes.</p>		<p>12D.3.2.2 Describe the procedures used to inspect, maintain, and troubleshoot FCAW welding equipment. (D11.7)</p>
			<p>12D.3.2.3 Identify the requirements and describe the procedures to store consumables used for FCAW welding of plate. (D11.a.4)</p>
			<p>12D.3.2.4 Describe the procedures used to assemble and disassemble MCAW welding equipment. (D11.b.5)</p>

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.** *(continued)*

**GLO 3.2:** Demonstrate the safe and appropriate **maintenance** and **storage** of equipment, materials, and consumable items. *(continued)*

12D.3.2.5 Describe the procedures used to inspect, maintain, and troubleshoot MCAW welding equipment. (D11.b.7)

12D.3.2.6 Identify requirements and describe the procedures to store consumables used for MCAW welding. (D11.c.4)

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.** *(continued)*

**GLO 3.3:** Demonstrate an awareness of **hoisting, lifting,** and **rigging** procedures.

12D.3.3.1 Define terminology associated with hoisting, lifting, and rigging. (A3.b.1)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance, and storage** of **equipment, materials, and consumable items.** *(continued)*

**GLO 3.3:** Demonstrate an awareness of **hoisting, lifting, and rigging** procedures. *(continued)*

---

12D.3.3.2 Identify hazards and describe safe work practices pertaining to hoisting, lifting, and rigging. (A3.b.2)

12D.3.3.3 Identify regulations pertaining to hoisting, lifting, and rigging. (A3.b.3)

12D.3.3.4 Identify types of rigging equipment and accessories, and describe their limitations, applications, and procedures for use. (A3.b.4)

12D.3.3.5 Identify types of hoisting and lifting equipment and accessories, and describe their applications and procedures for use. (A3.b.5)

---

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.** *(continued)*

**GLO 3.3:** Demonstrate an awareness of **hoisting, lifting,** and **rigging** procedures. *(continued)*

12D.3.3.6 Describe the procedures used to inspect, maintain, and store hoisting, lifting, and rigging equipment. (A3.b.6)

12D.3.3.7 Describe the procedures used to rig material/equipment for lifting. (A3.b.7)

12D.3.3.8 Describe the procedures used to attach and use tag lines. (A3.b.8)

12D.3.3.9 Describe the procedures used to ensure the work area is safe for lifting. (A3.b.9)

12D.3.3.10 Identify and describe the procedures used to communicate during hoisting, lifting, and rigging operations. (A3.b.10)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance, and storage** of **equipment, materials, and consumable items.** *(continued)*

**GLO 3.3:** Demonstrate an awareness of **hoisting, lifting, and rigging** procedures. *(continued)*

---

12D.3.3.11 Identify the factors to consider when selecting rigging equipment. (A3.b.11)

12D.3.3.12 Describe the procedures used to perform a lift. (A3.b.12)

---

**GLO 3.4:** Demonstrate an awareness of **access equipment.**

---

— — — 12D.3.4.1 Define terminology associated with access equipment. (A3.c.1)

12D.3.4.2 Identify hazards and describe safe work practices pertaining to access equipment. (A3.c.2)

12D.3.4.3 Identify regulations pertaining to access equipment. (A3.c.3)

---

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 3:** Demonstrate the **identification, operation, maintenance,** and **storage** of **equipment, materials,** and **consumable items.** *(continued)*

**GLO 3.4:** Demonstrate an awareness of **access equipment.** *(continued)*

12D.3.4.4 Identify types of access equipment, and describe their characteristics and applications. (A3.c.4)

12D.3.4.5 Identify types of fall protection and fall arrest equipment.

12D.3.4.6 Erect and dismantle access equipment. (A3.c.5 )

12D.3.4.7 Describe the procedures used to erect and dismantle access equipment. (A3.c.6)

12D.3.4.8 Describe the procedures used to inspect and maintain access equipment. (A3.c.7)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes.

**GLO 4.1:** Demonstrate **pre-welding** procedures.

12A.4.1.1 Prepare material and equipment for advanced GMAW welding.	12B.4.1.1 Prepare material and equipment for advanced SMAW welding.	12C.4.1.1 Prepare material and equipment for advanced project.	12D.4.1.1 Prepare material for the Manitoba Welder Practical Examination Structural Level.
		12C.4.1.2 Identify MCAW and FCAW welding processes, and describe their characteristics and applications. (D1.5.c & d)	12D.4.1.2 Describe the procedures used to assemble and disassemble FCAW welding equipment. (D11.5)
		12C.4.1.3 Identify the considerations when selecting consumables and determining equipment set-up for performing GMAW fillet welds on low carbon steel in all positions. (D6.a.3)	12D.4.1.3 Identify the considerations when selecting consumables and determining equipment set-up for performing FCAW fillet and groove welds on plate. (D11.a.3)
			12D.4.1.4 Describe the procedures used to prepare plate for FCAW fillet and groove welds. (D11.a.5)
			12D.4.1.5 Identify the considerations when selecting consumables and determining equipment set-up for performing MCAW fillet and groove welds. (D11.c.3)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.1:** Demonstrate **pre-welding** procedures. *(continued)*

12D.4.1.6 Describe the procedures used to prepare base metals and joints for MCAW fillet and groove welds. (D11.c.5)

**GLO 4.2:** Demonstrate **ability to weld**.

12A.4.2.1 Define terminology associated with FCAW welding. (D11.1)

12B.4.2.1 Perform fillet welds on low carbon steel in all positions. (D3.a.8)

12C.4.2.1 Perform welds in an advanced welding project.

12D.4.2.1 Identify GTAW, stud welding, resistance welding, and SAW welding processes, and describe their characteristics and applications. (D1.5.e, f, g, & h)

12A.4.2.2 Perform GMAW, FCAW, and MCAW processes.

12B.4.2.2 Perform 1G welds using SMAW.

12D.4.2.2 Describe the procedures and techniques used to deposit a weld bead using FCAW welding equipment. (D11.6)

12A.4.2.3 Perform combined GMAW and FCAW welds on mild steel.

12B.4.2.3 Perform 1G 1F welds using SMAW.

12D.4.2.3 Describe the procedures used to perform fillet and groove welds on plate using the FCAW process. (D11.a.6)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.2:** Demonstrate **ability to weld**. *(continued)*

12A.4.2.4 Perform the procedures used to perform fillet and groove welds using the MCAW process. (D11.c.6)

12A.4.2.5 Identify the modes of transfer relating to GMAW welding, and describe their characteristics and applications. (D6.7)

12A.4.2.6 Describe the procedures used to perform fillet welds on low carbon steel plate in all positions using the GMAW process. (D6.a.6)

12A.4.2.7 Perform fillet welds on low carbon steel plate in all positions. (D6.a.8)

12D.4.2.4 Describe the procedures and techniques used to weld bead using MCAW equipment. (D11.b.6)

12D.4.2.5 Perform the procedures used to perform fillet and groove welds using the MCAW process. (D11.c.6)

**GLO 4.3:** Perform **post-welding** procedures.

12A.4.3.1 Perform post-welding procedures for advanced GMAW welding.

12B.4.3.1 Perform post-welding procedures for advanced SMAW welding.

12C.4.3.1 Perform post-welding procedures for advanced projects.

12D.4.3.1 Perform post-welding procedures for the Manitoba Welder Practical Examination Structural Level.

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 4:** Demonstrate an understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.4:** Inspect and **troubleshoot** welding projects.

12A.4.4.1 Inspect and troubleshoot advanced GMAW welds.	12B.4.4.1 Inspect and troubleshoot advanced SMAW welds.	12C.4.4.1 Inspect and troubleshoot advanced project welds.	12D.4.4.1 Inspect and troubleshoot Manitoba Welder Practical Examination Structural Level welds.
12A.4.4.2 Describe the procedures used to prevent and correct weld faults. (D6.a.7)			12D.4.4.2 Describe the procedures used to prevent and correct weld faults. (D11.c.7)
			12D.4.4.3 Perform the procedures used to gouge using oxy-fuel equipment. (C3.10)

**GLO 4.5:** Perform the **Manitoba Welder Practical Examinations.**

—	—	—	12D.4.5.1 Identify welding test positions and describe their characteristics and restrictions. (D1.10)
			12D.4.5.2 Perform the Oxy/Acetylene Cutting Practical Examination. (E1.A)
			12D.4.5.3 Successfully complete the Flat GMAW Practical 1F Examination. (E1.B)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 4:** Demonstrate understanding of **welding processes** and exhibit competence in those processes. *(continued)*

**GLO 4.5:** Perform the **Manitoba Welder Practical Examinations**. *(continued)*

12D.4.5.4 Successfully complete the Flat MCAW Practical 1F Examination. (E1.C)

12D.4.5.5 Successfully complete the Flat SMAW Practical 1F Examination. (E1.D)

**Goal 5:** Demonstrate an understanding of **metal design and fabrication**.

**GLO 5.1: Design** metal projects.

12A.5.1.1 Interpret information pertaining to GMAW fillet welds found on drawings and specifications. (D6.a.2)

—

12C.5.1.1 Demonstrate awareness of pattern development.

12C.5.1.2 Demonstrate an awareness of geometric construction.

12C.5.1.3 Identify basic isometric and oblique drawings.

12D.5.1.1 Interpret information pertaining to FCAW fillet and groove welds found on drawings and specifications. (D11.a.2)

12D.5.1.2 Interpret information pertaining to the MCAW fillet and groove welds found on drawings and specifications. (D11.c.2)

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 5:** Demonstrate an understanding of **metal design and fabrication.** *(continued)*

**GLO 5.1: Design** metal projects. *(continued)*

12C.5.1.4 Develop a shop drawing of a metals project.

**GLO 5.2: Fabricate** metal projects.

12A.5.2.1 Cut, prep, and tack the five basic weld joints.

12B.5.2.1 →

12C.5.2.1 →

—

12C.5.2.2 Fabricate advanced metal projects.

12C.5.2.3 Cut material for an advanced project, following specific measurements, angles, etc.

12C.5.2.4 Perform material preparation and fit-up for an advanced project.

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 6:** Describe and apply the transferable **cross-curricular** knowledge and skills.

**GLO 6.1:** Apply knowledge and skills from the **language arts**.

12A.6.1.1 Define terminology associated with GMAW fillet welds. (D6.a.1)	—	—	<p>12D.6.1.1 Define terminology associated with FCAW welding. (D11.1)</p> <p>12D.6.1.2 Define terminology associated with FCAW fillet and groove welds. (D11.a.1)</p> <p>12D.6.1.3 Define terminology associated with MCAW welding. (D11.b.1)</p> <p>12D.6.1.4 Define terminology associated with MCAW fillet and groove welds. (D11.c.1)</p>
--------------------------------------------------------------------------	---	---	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

**GLO 6.2:** Demonstrate the **mathematics** skills related to welding.

12A.6.2.1 Solve problems involving percentage and ratios. (B3.3)	—	—	—
12A.6.2.2 Solve problems involving geometric formulas. (B3.5)			

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 6:** Describe and apply the transferable **cross-curricular** knowledge and skills. *(continued)*

**GLO 6.3:** Demonstrate knowledge of **other subject areas**.

12A.6.3.1 Demonstrate an awareness of the use of information and communication technology in creating electronic portfolios and searching for employment.	12B.6.3.1 →	12C.6.3.1 →	12D.6.3.1 →
12A.6.3.2 Read, interpret, and communicate welding symbols.	12B.6.3.2 →	12C.6.3.2 →	12D.6.3.2 →
		12C.6.3.3 Read and interpret blueprints and welding symbols.	
		12C.6.3.4 Identify types of trades related to documentation, and describe their applications and procedures for use. (A1.a.3)	

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 7:** Follow the **ethical** and **legal standards** that pertain to the welding industry.

**GLO 7.1:** Demonstrate an awareness of the **ethical** and **legal expectations** of welders.

12A.7.1.1 Demonstrate an understanding of the history of welding certification as it relates to safety in the welding industry.	12B.7.1.1 Demonstrate an awareness of types of destructive and non-destructive welding inspections.	12C.7.1.1 Demonstrate ethics by practising quality workmanship.	12D.7.1.1 Demonstrate an awareness of various types of welding certification.
	12B.7.1.2 Identify codes and standards pertaining to SMAW welding. (D3.3)	12C.7.1.2 Identify codes and standards pertaining to welding. (D1.4)	12D.7.1.2 Identify codes and standards pertaining to FCAW welding. (D11.3)
			12D.7.1.3 Identify codes and standards pertaining to MCAW welding. (D11.b.3)

**Goal 8:** Demonstrate **employability skills**.

**GLO 8.1:** Demonstrate **employability skills**.

12A.8.1.1 Demonstrate problem-solving skills.	12B.8.1.1 →	12C.8.1.1 →	12D.8.1.1 →
12A.8.1.2 Demonstrate critical thinking skills.	12B.8.1.2 →	12C.8.1.2 →	12D.8.1.2 →
12A.8.1.3 Demonstrate regular attendance and punctuality.	12B.8.1.3 →	12C.8.1.3 →	12D.8.1.3 →

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 8:** Demonstrate **employability skills.** *(continued)*

**GLO 8.1:** Demonstrate **employability skills.** *(continued)*

12A.8.1.4 Demonstrate accountability for their actions.	12B.8.1.4 →	12C.8.1.4 →	12D.8.1.4 →
12A.8.1.5 Demonstrate adaptability, initiative, and effort.	12B.8.1.5 →	12C.8.1.5 →	12D.8.1.5 →
12A.8.1.6 Demonstrate the ability to accept and follow direction and feedback.	12B.8.1.6 →	12C.8.1.6 →	12D.8.1.6 →
12A.8.1.7 Demonstrate teamwork skills.	12B.8.1.7 →	12C.8.1.7 →	12D.8.1.7 →
12A.8.1.8 Demonstrate the ability to stay on task and effectively use time in class and shop environments.	12B.8.1.8 →	12C.8.1.8 →	12D.8.1.8 →
12A.8.1.9 Demonstrate the ability to communicate respectfully and effectively with teachers and students.	12B.8.1.9 →	12C.8.1.9 →	12D.8.1.9 →

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 9:** Demonstrate an awareness of **sustainability** as it pertains to the welding industry.

**GLO 9.1:** Describe the impact of **human sustainability** on the health and well-being of welders.

12A.9.1.1 Demonstrate an awareness of the long-term health concerns related to welding different types of materials, such as stainless galvanized steels.	12B.9.1.1 Analyze the effect of welding on human long-term health and well-being.	—	—
12A.9.1.2 Research safety concerns related to different types of filler materials.	12B.9.1.2 Demonstrate an awareness of short-term and long-term effects of welding, grinding, and metalwork on hearing, respiratory system, and eye health.		

**GLO 9.2:** Describe the welding industry's **sustainability practices** and impact on the environment.

12A.9.2.1 Demonstrate an awareness of the impact of welding work sites on the environment.	12B.9.2.1 →	12C.9.2.1 →	12D.9.2.1 →
--------------------------------------------------------------------------------------------	-------------	-------------	-------------

**GLO 9.3:** Describe the **sustainable business practices** within the welding industry.

—	12B.9.3.1 Demonstrate an awareness of how the welding industry and welding products can adapt to a changing economy.	—	—
---	----------------------------------------------------------------------------------------------------------------------	---	---

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 10:** Demonstrate an understanding of the **structure** and **scope** of welding.

**GLO 10.1:** Describe the **scope** of welding.

12A.10.1.1 Demonstrate an awareness of the scope of GMAW (MIG) welding.	12B.10.1.1 Demonstrate an awareness of the scope of SMAW (ARC) welding.	12C.10.1.1 Demonstrate an awareness of the scope of metal design and fabrication.	—
-------------------------------------------------------------------------	-------------------------------------------------------------------------	-----------------------------------------------------------------------------------	---

**GLO 10.2:** Describe **apprenticeship, post-secondary,** and **employment opportunities.**

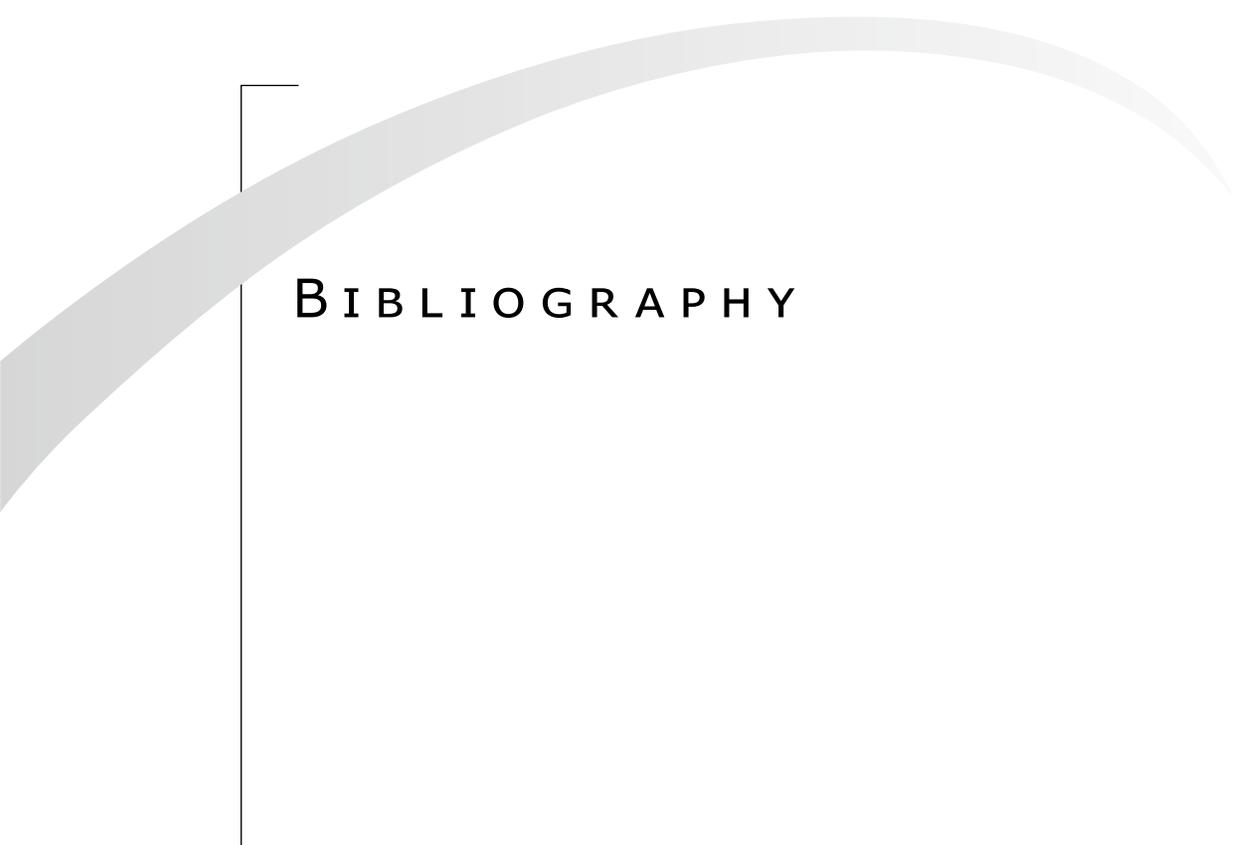
—	—	12C.10.2.1 Demonstrate an awareness of employment opportunities in metal design/fabrication.	<p>12D.10.2.1 Describe the Manitoba Welder Apprenticeship Program. (A2.2)</p> <p>12D.10.2.2 Explain special challenges and opportunities re: apprenticeship training. (A2.3)</p> <p>12D.10.2.3 Demonstrate an awareness of accommodation for apprentices with disabilities. (A2.4)</p> <p>12D.10.2.4 Demonstrate an awareness of the advantages of certification for welders.</p> <p>12D.10.2.5 Demonstrate the skills required to obtain employment as a welder or in a related occupation.</p>
---	---	----------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

8487 <b>Advanced GMAW (MIG) Welding Processes and Procedures (12A)</b> 40S / 40E / 40M	8488 <b>Advanced SMAW (ARC) Welding Processes and Procedures (12B)</b> 40S / 40E / 40M	8489 <b>Advanced Metal Design/Fabrication (12C)</b> 40S / 40E / 40M	8503 <b>Applied Specialties and Qualifications (12D)</b> 40S / 40E / 40M
------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

**Goal 11:** Demonstrate an understanding of the **evolution, technological progression, and emerging trends** in welding.

**GLO 11.1:** Demonstrate an understanding of the **evolution, technological progression, and emerging trends** in welding.

12A.11.1.1 Demonstrate an awareness of PULSE welding.	12B.11.1.1 Demonstrate an awareness of the welding of exotic materials.	12C.11.1.1 Demonstrate an awareness of technological progression and emerging trends in metal design and fabrication.	—
12A.11.1.2 Demonstrate an understanding of the use of lasers for cutting and welding.	12B.11.1.2 Research new technologies such as virtual welding devices used to teach welding.		



# BIBLIOGRAPHY



## BIBLIOGRAPHY

- Apprenticeship Manitoba. "Welder." *Manitoba Trades*. n.d. <https://www.gov.mb.ca/wd/apprenticeship/discover/mbtrades/welder.html> (date of access – 05 February 2018).
- . *Welder Level 1*. Winnipeg, MB: Apprenticeship Manitoba, December 2016. <https://www.gov.mb.ca/wd/apprenticeship/discover/mbtrades/welder.html> (date of access – 05 February 2018).
- . *Unit to Course Comparison (UCC) Form – Welder Level 1*. Winnipeg, MB: Apprenticeship Manitoba, August 2015. [www.edu.gov.mb.ca/k12/cur/teched/sytep/welding/ucc\\_form.pdf](http://www.edu.gov.mb.ca/k12/cur/teched/sytep/welding/ucc_form.pdf) (date of access – 05 February 2018).
- Bowditch, William A., Kevin E. Bowditch, and Mark A. Bowditch. *Welding Fundamentals*. Tinley Park, IL: Goodheart-Willcox Publishers, 2017.
- . *Welding Fundamentals: Examview Assessment Suite*. Tinley Park, IL: Goodheart-Willcox Publishers, 2017.
- . *Welding Fundamentals: Instructor's Resource CD*. Tinley Park, IL: Goodheart-Willcox Publishers, 2017.
- . *Welding Fundamentals: Lab Workbook*. Tinley Park, IL: Goodheart-Willcox Publishers, 2017.
- . *Welding Fundamentals: Instructor's Presentations for PowerPoint*. Tinley Park, IL: Goodheart-Willcox Publishers, 2017.
- Jeffus, Larry. *Welding and Metal Fabrication: Student Resource*. Toronto, ON: Nelson Education, 2012.
- . *Welding and Metal Fabrication: Workbook*. Toronto, ON: Nelson Education, 2012.
- . *Welding and Metal Fabrication: Instructor Resource*. Toronto, ON: Nelson Education, 2012.
- Manitoba Apprenticeship and Certification Board. *Trade Safety Awareness Curriculum for Level 1 Apprentices*. Winnipeg, MB: Province of Manitoba, 2013. Available online at <https://www.gov.mb.ca/wd/apprenticeship/generalinfo/print,instructoreducators.html>.
- Manitoba Education. *Technical Vocational Education Overview*. Winnipeg, MB: Manitoba Education, 2013. Available online at [www.edu.gov.mb.ca/k12/cur/teched/sytep/docs/overview.pdf](http://www.edu.gov.mb.ca/k12/cur/teched/sytep/docs/overview.pdf).
- Manitoba Education and Training. *Technical Vocational: Welding Technology Grades 9–12: A Reference for Selecting Learning Resources*. Winnipeg, MB: Manitoba Education and Training, 2016. Available online at [www.edu.gov.mb.ca/k12/learnres/tech\\_voc/welding\\_tech/bib\\_gr9-12.pdf](http://www.edu.gov.mb.ca/k12/learnres/tech_voc/welding_tech/bib_gr9-12.pdf).
- Proctor, Thomas E., and Jonathan F. Gross. *ATP: Welding: Printreading for Welders*. Toronto, ON: Nelson Education, 2014.

———. *ATP: Welding: Printreading for Welders: Online Instructor Resources*. Toronto, ON: Nelson Education, 2014.

Red Seal Program. *Industrial Welder National Occupational Analysis*. Gatineau, QC: Red Seal Program. 2014.  
Available online at [www.red-seal.ca/tr.1d.2@-eng.jsp?tid=250](http://www.red-seal.ca/tr.1d.2@-eng.jsp?tid=250).





Printed in Canada  
Imprimé au Canada