RED SEAL

THE INTERPROVINCIAL STANDARDS RED SEAL PROGRAM

Interprovincial Program Guide

2013

Sheet Metal Worker

Human Resources and Social Development Canada
Ressources humaines et Développement social Canada

Canada

Interprovincial Program Guide

Sheet Metal Worker

2013

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Foreword

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Interprovincial Program Guide (IPG) as the national curriculum for the occupation of Sheet Metal Worker.

Jurisdictions have long recognized the benefit of pooling resources in the development and maintenance of apprenticeship training standards. A successful example of this is the Interprovincial Standards Red Seal Program itself. Essential to the establishment of standards is the development of suitable training systems and programs which enable tradespeople to acquire certification based on these standards. While certification is the responsibility of Apprenticeship administrators throughout Canada, the development and delivery of technical training is the responsibility of jurisdictions.

In 1999, work to develop common training for apprenticeship programs within the Atlantic Provinces began. To date, 22 Curriculum Standards have been developed through the Atlantic Standards Partnership (ASP) project to assist programming staff and instructors in the design and delivery of technical training. Similarly, the CCDA embarked on a process for the development of national IPGs for the Boilermaker, Carpenter and Sprinkler System Installer trades. At its January 2005 strategic planning session, the CCDA identified developing common training standards as one of the key activities in moving towards a more cohesive apprenticeship system.

With the support of Human Resources and Skills Development Canada (HRSDC), several provinces and territories have partnered to build on the ASP and the CCDA processes to further develop IPGs to be used across the country. This partnership will create efficiencies in time and resources and promote consistency in training and apprentice mobility.

Acknowledgements

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Gary Kelpatz	Manitoba
Duane Maillet	New Brunswick
Dennis Smith	Manitoba

In addition to the representatives above, various federal, provincial and territorial representatives contributed to the development of this document including the host province of New Brunswick.

In 2012, a review, update and jurisdictional validation of this IPG were completed to ensure adequate coverage of the occupation as outlined in the 2010 National Occupational Analysis (NOA).

As this program guide will be amended periodically, comments or suggestions for improvement should be directed to:

Trades and Apprenticeship Division
Labour Market Integration Directorate
Human Resources and Skills Development Canada
140 Promenade du Portage, Phase IV, 5th Floor
Gatineau, Quebec K1A 0J9
e-mail: redseal-sceaurouge@hrsdc-rhdcc.gc.ca

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PROGRAM CONTENT

User Guide

According to the Canadian Apprenticeship Forum, the IPG is: "a list of validated technical training outcomes, based upon those sub-tasks identified as common core in the National Occupational Analysis (NOA), and validated by industry in the provinces and territories as incorporating the essential tasks, knowledge and skills associated with a given trade."

Learning outcomes contained in the IPG represent the minimum common core content for the development of jurisdictional training standards and outlines. IPGs are developed based on the NOAs and extensive industry consultation. The IPG is intended to assist program development staff in the design of jurisdictional plans of training. Each jurisdiction has the flexibility to add additional content.

The IPG was deliberately constructed for ease of use and flexibility of structure in order to adapt to all delivery requirements. It details units of training, unit outcomes and objectives. It does not impose a delivery model or teaching format.

Jurisdictions and/or training providers will select and develop delivery materials and techniques that accommodate a variety of learning styles and delivery patterns. The IPG does not dictate study materials, textbooks or learning activities to be used in delivery.

The IPG document includes a recommended levelling structure to facilitate mobility for apprentices moving from one jurisdiction to another. Because of difference in jurisdictional regulations and program durations, levels are offered as suggestions only.

Structure

The IPG is divided into units. The unit codes are used as a means of identification and are not intended to convey the order of delivery. Prerequisites have not been detailed. Each unit consists of *Learning Outcomes* and *Objectives and Content.*

The *Learning Outcomes* are the specific performances that must be evaluated. Wording of the learning outcomes, "Demonstrate knowledge of…", acknowledges the broad spectrum of ways in which knowledge can be shown. It is at the discretion of each jurisdiction to determine the manner in which learning outcomes are evaluated; theoretically, practically or a combination of both.

The *Objectives and Content* for the unit details the information to be covered in order to achieve the performances specified in the *Learning Outcomes*. These objectives can be either theoretical or practical in nature, based on the requirements identified through the industry consultation process. The learning activities used to cover the objectives are at the discretion of the jurisdiction; however, practically worded objective statements have been used where industry indicated a need for the apprentices to receive exposure to performing the task or skill outlined while attending technical training. For example, this exposure could be done through instructor demonstration or individual or group performance of the skill or task. This practical training will help to reinforce the theoretical component of the technical training.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. The content listed within the IPG document is **not** intended to represent an inclusive list; rather, it is included to illustrate the intended direction for the objective. Content may be added or extended in jurisdictional training plans as required.

Jurisdictions are free to deliver the IPG units one at a time or concurrently, provided that all *Learning Outcomes* are met. The IPG does not indicate the amount of time to be spent on a particular unit as the length of time required to deliver the *Learning Outcomes* successfully will depend upon the learning activities and teaching methods used.

IPG Glossary of Terms

These definitions are intended as a guide to how language is used in the IPGs.

APPLICATION	The use to which something is put and/or the circumstance in which you would use it.
CHARACTERISTIC	A feature that helps to identify, tell apart, or describe recognizably; a distinguishing mark or trait.
COMPONENT	A part that can be separated from or attached to a system; a segment or unit.
DEFINE	To state the meaning of (a word, phrase, etc.).
DESCRIBE	To give a verbal account of; tell about in detail.
EXPLAIN	To make plain or clear; illustrate; rationalize.
IDENTIFY	To point out or name objectives or types.
INTERPRET	To translate information from observation, charts, tables, graphs, and written material.
MAINTAIN	To keep in a condition of good repair or efficiency.
METHOD	A means or manner of doing something that has procedures attached to it.
OPERATE	How an object works; to control or direct the functioning of.
PROCEDURE	A prescribed series of steps taken to accomplish an end.
PURPOSE	The reason for which something exists or is done, made or used.

TEST	v. To subject to a procedure that ascertains effectiveness, value, proper function, or other quality. n. A way of examining something to determine its characteristics or properties, or to determine whether or not it is working correctly.
TROUBLESHOOT	To follow a systematic procedure to identify and locate a problem or malfunction and its cause.

Essential Skills Profiles

Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all the other skills that enable people to evolve within their jobs and adapt to workplace change.

Over the past several years, the Government of Canada has conducted research examining the skills people use at work. From this research, Essential Skills Profiles have been developed for various occupations.

For more information regarding Essential Skills and to access Essential Skills Profiles for specific occupations, visit Human Resources and Skills Development Canada's Essential Skills website at:

http://www.hrsdc.gc.ca/eng/workplaceskills/LES/profiles/profiles.shtml

Profile Chart

OCCUPATIONAL SKILLS			
SMW-100 Safety	**SMW-105** Communication	**SMW-110** Tools and Equipment	**SMW-115** Ladders and Work Platforms
SMW-120 Metallurgy	**SMW-130** Introduction to Gas Metal Arc Welding (GMAW)	**SMW-135** Plasma Arc Cutting	**SMW-140** Soldering
SMW-145 Pattern Development and Layout	**SMW-165** Resistance Spot Welding	**SMW-205** Hoisting, Lifting and Rigging	**SMW-210** Drawings and Specifications
SMW-230 Advanced Gas Metal Arc Welding (GMAW)	**SMW-235** Introduction to Gas Tungsten Arc Welding (GTAW)	**SMW-300** Advanced Gas Tungsten Arc Welding (GTAW)	**SMW-325** Duct System Design
SMW-425 Shielded Metal Arc Welding (SMAW)	**SMW-430** Oxy-fuel Cutting, Heating and Brazing	**SMW-440** Trade Related Documents	**SMW-445** Job Planning
SHEET METAL FABRICATION			
SMW-125 Drafting	**SMW-150** Simple Layout	**SMW-155** Fabrication Fundamentals	**SMW-160** Fastening and Retaining Devices
SMW-215 Parallel Line Development (Round Duct Fittings)	**SMW-220** Radial Line Development (Right Cones)	**SMW-225** Triangulation (From Plan View)	**SMW-240** Fabrication (Air Handling Systems and Components)
SMW-310 Parallel Line Development (Architectural Applications)	**SMW-315** Radial Line Development (Oblique Fittings)	**SMW-320** Triangulation (From Elevation)	**SMW-400** Fabrication (Material Handling Systems and Components)
AIR AND MATERIAL HANDLING SYSTEM INSTALLATION			
SMW-245 Installation (Air Handling Systems)	**SMW-330** Air Quality Management	**SMW-335** Chimneys, Breeching and Venting	**SMW-405** Installation (Material Handling Systems)

Profile Chart *(continued)*

ROOFING, ARCHITECTURAL METAL AND SPECIALTY PRODUCT INSTALLATION			
SMW-420 Metal Roofing and Architectural Metal	**SMW-435** Specialty Products		
MAINTENANCE AND REPAIR			
SMW-410 Maintenance and Repair (Air and Material Handling Systems)	**SMW-415** Testing, Adjusting and Balancing (Air and Material Handling Systems)	**SMW-450** Electrical Principles	

Recommended Level Structure

Level 1			Level 2		
Unit Code	**Title**	**Page**	**Unit Code**	**Title**	**Page**
SMW-100	Safety	19	SMW-205	Hoisting, Lifting and Rigging	37
SMW-105	Communication	20	SMW-210	Drawings and Specifications	40
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SMW-115	Ladders and Work Platforms	22	SMW-220	Radial Line Development (Right Cones)	43
SMW-120	Metallurgy	23	SMW-225	Triangulation (From Plan View)	44
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SMW-130	Introduction to Gas Metal Arc Welding (GMAW)	26	SMW-235	Introduction to Gas Tungsten Arc Welding (GTAW)	47
SMW-135	Plasma Arc Cutting	28	SMW-240	Fabrication (Air Handling Systems and Components)	49
SMW-140	Soldering	29	SMW-245	Installation (Air Handling Systems)	51
SMW-145	Pattern Development and Layout	30			
SMW-150	Simple Layout	31			
SMW-155	Fabrication Fundamentals	32			
SMW-160	Fastening and Retaining Devices	34			
SMW-165	Resistance Spot Welding	35			

Level 3			Level 4		
Unit Code	**Title**	**Page**	**Unit Code**	**Title**	**Page**
SMW-300	Advanced Gas Tungsten Arc Welding (GTAW)	55	SMW-400	Fabrication (Material Handling Systems and Components)	65
SMW-310	Parallel Line Development (Architectural Applications)	56	SMW-405	Installation (Material Handling Systems)	67
SMW-315	Radial Line Development (Oblique Fittings)	57	SMW-410	Maintenance and Repair (Air and Material Handling Systems)	68
SMW-320	Triangulation (From Elevation)	58	SMW-415	Testing, Adjusting and Balancing (Air and Material Handling Systems)	71
SMW-325	Duct System Design	59	SMW-420	Metal Roofing and Architectural Metal	73
SMW-330	Air Quality Management	60	SMW-425	Shielded Metal Arc Welding (SMAW)	76
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			SMW-435	Specialty Products	80
			SMW-440	Trade Related Documents	82
			SMW-445	Job Planning	83
			SMW-450	Electrical Principles	84

2010 NOA Sub-task to IPG Unit Comparison

NOA Sub-task		IPG Unit	
Task 1 – Uses tools and equipment.			
1.01	Uses personal protective equipment (PPE) and safety equipment.	SMW-100	Safety
1.02	Maintains hand tools.	SMW-110	Tools and Equipment
1.03	Maintains portable power tools.	SMW-110	Tools and Equipment
1.04	Maintains shop tools and equipment.	SMW-110	Tools and Equipment
1.05	Maintains welding/cutting equipment.	SMW-110	Tools and Equipment
		SMW-130	Introduction to Gas Metal Arc Welding (GMAW)
		SMW-135	Plasma Arc Cutting
		SMW-165	Resistance Spot Welding
		SMW-230	Advanced Gas Metal Arc Welding (GMAW)
		SMW-235	Introduction to Gas Tungsten Arc Welding (GTAW)
		SMW-300	Advanced Gas Tungsten Arc Welding (GTAW)
		SMW-425	Shielded Metal Arc Welding (SMAW)
		SMW-430	Oxy-fuel Cutting, Heating and Brazing/Hard Soldering
1.06	Maintains soldering/brazing equipment.	SMW-110	Tools and Equipment
		SMW-140	Soldering
		SMW-430	Oxy-fuel Cutting, Heating and Brazing/Hard Soldering
1.07	Maintains measuring and layout equipment.	SMW-110	Tools and Equipment
		SMW-145	Pattern Development and Layout
1.09	Uses ladders and platforms.	SMW-115	Ladders and Work Platforms
1.10	Uses hoisting and rigging equipment.	SMW-205	Hoisting, Lifting and Rigging
Task 2 – Organizes work.			
2.01	Maintains safe work environment.	SMW-100	Safety
2.02	Interprets documentation.	SMW-440	Trade Related Documents
2.03	Interprets drawings.	SMW-125	Drafting
		SMW-210	Drawings and Specifications
		SMW-445	Job Planning
2.04	Completes documentation.	SMW-440	Trade Related Documents
2.05	Communicates with others.	SMW-105	Communication
2.06	Organizes materials.	SMW-440	Trade Related Documents

NOA Sub-task		IPG Unit	
2.07	Performs basic design and field modifications.	SMW-145	Pattern Development and Layout
		SMW-245	Installation (Air Handling Systems)
		SMW-325	Duct System Design
		SMW-405	Installation (Material Handling Systems)
2.08	Performs inspection.	SMW-410	Maintenance and Repair (Air and Material Handling Systems)
Task 3 – Performs pattern development.			
3.01	Develops pattern using triangulation method.	SMW-225	Triangulation (From Plan View)
		SMW-320	Triangulation (From Elevation)
3.02	Develops pattern using radial line method.	SMW-220	Radial Line Development (Right Cones)
		SMW-315	Radial Line Development (Oblique Fittings)
3.03	Develops pattern using parallel line method.	SMW-215	Parallel Line Development (Round Duct Fittings)
		SMW-310	Parallel Line Development (Architectural Applications)
3.04	Develops pattern using simple and straight line layout.	SMW-150	Simple Layout
3.05	Develops pattern using computer technology.	SMW-145	Pattern Development and Layout
3.06	Labels pieces.	SMW-150	Simple Layout
		SMW-215	Parallel Line Development (Round Duct Fittings)
		SMW-220	Radial Line Development (Right Cones)
		SMW-225	Triangulation (From Plan View)
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-310	Parallel Line Development (Architectural Applications)
		SMW-315	Radial Line Development (Oblique Fittings)
		SMW-320	Triangulation (From Elevation)
		SMW-400	Fabrication (Material Handling Systems and Components)
Task 4 – Fabricates sheet metal components for air and material handling systems.			
4.01	Cuts ductwork, fittings and components.	SMW-155	Fabrication Fundamentals
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)

NOA Sub-task		IPG Unit	
4.02	Forms ductwork, fittings and components.	SMW-120	Metallurgy
		SMW-155	Fabrication Fundamentals
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
4.03	Insulates ductwork, fittings and components.	SMW-120	Metallurgy
		SMW-155	Fabrication Fundamentals
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
4.04	Assembles ductwork, fittings and components.	SMW-120	Metallurgy
		SMW-155	Fabrication Fundamentals
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
4.05	Fabricates dampers.	SMW-120	Metallurgy
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
4.06	Fabricates flexible connections.	SMW-120	Metallurgy
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
4.07	Fabricates hanger systems.	SMW-120	Metallurgy
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
4.08	Fabricates supports and bases.	SMW-120	Metallurgy
		SMW-240	Fabrication (Air Handling Systems and Components)
		SMW-400	Fabrication (Material Handling Systems and Components)
Task 5 – Fabricates roofing, sheeting and cladding.			
5.01	Determines seams.	SMW-420	Metal Roofing and Architectural Metal
5.02	Cuts metal for flashing, roofing, sheeting and cladding.		
5.03	Forms flashing, roofing, sheeting and cladding.		

NOA Sub-task		IPG Unit	
Task 6 – Fabricates specialty products.			
6.01	Cuts material for specialty products.	SMW-435	Specialty Products
6.02	Forms specialty products.		
6.03	Assembles products.		
6.04	Finishes material.		
Task 7 – Prepares installation site.			
7.01	Performs onsite measurements.	SMW-245	Installation (Air Handling Systems)
		SMW-405	Installation (Material Handling Systems)
7.02	Performs demolitions for renovations.	SMW-245	Installation (Air Handling Systems)
		SMW-335	Chimneys, Breeching and Venting
		SMW-405	Installation (Material Handling Systems)
7.03	Cuts penetrations.	SMW-245	Installation (Air Handling Systems)
		SMW-405	Installation (Material Handling Systems)
7.04	Installs supports and bases.	SMW-245	Installation (Air Handling Systems)
		SMW-405	Installation (Material Handling Systems)
7.05	Installs hangers, braces and brackets.	SMW-245	Installation (Air Handling Systems)
		SMW-335	Chimneys, Breeching and Venting
		SMW-405	Installation (Material Handling Systems)
Task 8 – Installs chimneys, breeching and venting.			
8.01	Installs chimney, breeching and venting primary components.	SMW-335	Chimneys, Breeching and Venting
8.02	Connects chimney, breeching and venting to appliance.		
Task 9 – Installs air handling system components.			
9.01	Installs air handlers.	SMW-245	Installation (Air Handling Systems)
		SMW-450	Electrical Principles
9.02	Installs heat recovery ventilators (HRVs).	SMW-245	Installation (Air Handling Systems)
		SMW-330	Air Quality Management
		SMW-450	Electrical Principles
9.03	Installs sheet metal ducts and fittings.	SMW-245	Installation (Air Handling Systems)
9.04	Installs dampers.	SMW-245	Installation (Air Handling Systems)
		SMW-450	Electrical Principles
9.05	Installs fire dampers.	SMW-245	Installation (Air Handling Systems)
9.06	Installs registers, grilles, diffusers and louvers.	SMW-245	Installation (Air Handling Systems)
9.07	Installs terminal boxes.	SMW-245	Installation (Air Handling Systems)

NOA Sub-task		IPG Unit	
9.08	Installs coils.	SMW-245	Installation (Air Handling Systems)
		SMW-330	Air Quality Management
9.09	Installs system component accessories.	SMW-245	Installation (Air Handling Systems)
		SMW-330	Air Quality Management
		SMW-450	Electrical Principles
Task 10 – Installs material handling system components.			
10.01	Installs pneumatic and gravity material handling system components.	SMW-405	Installation (Material Handling Systems)
10.02	Installs mechanical material handling system components.		
10.03	Installs collection and separating devices.		
Task 11 – Installs thermal insulation, lagging cladding and flashing.			
11.01	Applies thermal insulation to components.	SMW-245	Installation (Air Handling Systems)
		SMW-405	Installation (Material Handling Systems)
11.02	Applies lagging and cladding to components.	SMW-245	Installation (Air Handling Systems)
		SMW-405	Installation (Material Handling Systems)
11.03	Applies flashing to components.	SMW-245	Installation (Air Handling Systems)
		SMW-405	Installation (Material Handling Systems)
Task 12 – Performs testing, adjusting and balancing.			
12.02	Performs air balancing.	SMW-415	Testing, Adjusting and Balancing (Air and Material Handling Systems)
Task 13 – Installs metal roofing and cladding systems.			
13.01	Lays out roof and walls.	SMW-420	Metal Roofing and Architectural Metal
13.03	Installs roofing and cladding system components.		
13.04	Seals exposed joints.		
13.05	Installs decking.		
Task 14 – Installs exterior components.			
14.01	Prepares surface.	SMW-420	Metal Roofing and Architectural Metal
14.02	Fastens exterior components.		
Task 15 – Installs specialty products.			
15.01	Installs stainless steel specialty products.	SMW-120	Metallurgy
		SMW-435	Specialty Products
15.02	Installs non-stainless steel products.	SMW-435	Specialty Products
Task 16 – Performs scheduled maintenance.			
16.01	Performs maintenance inspection.	SMW-410	Maintenance and Repair (Air and Material Handling Systems)
16.02	Services components.		

NOA Sub-task		IPG Unit	
Task 17 – Repairs faulty systems and components.			
17.01	Diagnoses system faults	SMW-410	Maintenance and Repair (Air and Material Handling Systems)
17.02	Repairs worn, faulty or obsolete components.	SMW-450	Electrical Principles

LEVEL 1

SMW-100 Safety

Learning Outcomes:

- Demonstrate knowledge of safety equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of regulatory requirements pertaining to safety.

Objectives and Content:

1. Identify types of personal protective equipment (PPE) and describe their applications.

2. Describe the procedures used to care for and maintain PPE.

3. Identify workplace hazards and describe safe work practices and equipment.
   - i) personal
   - ii) workplace
     - electrical
     - confined space (awareness of)
     - fire
     - tag-out/lock-out
     - fall arrest
     - hoisting (awareness of)
     - asbestos
   - iii) environmental

4. Identify and interpret workplace safety and health regulations.
   - i) federal
     - Material Safety Data Sheets (MSDS)
     - Workplace Hazardous Material Information System (WHMIS)
   - ii) provincial/territorial
     - Occupational Health and Safety (OH&S)
   - iii) municipal

SMW-105 Communication

Learning Outcomes:

- Demonstrate knowledge of effective communication practices.
- Demonstrate knowledge of communication equipment and their applications.

Objectives and Content:

1. Define terminology associated with effective communication practices.

2. Describe effective communication practices.
   i) respectful
   ii) organized

3. Describe the importance of effective communication practices.
   i) customers
   ii) co-workers
   iii) related industry people
      - manufacturers
      - suppliers
      - consultants

4. Describe the importance of the coaching and mentoring relationship between journeyperson and apprentice.

5. Identify the types of communication methods and equipment, and describe their applications.

SMW-110 Tools and Equipment

Learning Outcomes:

- Demonstrate knowledge of tools and equipment, their applications, maintenance and procedures for use.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to tools and equipment.

2. Identify types of hand tools and describe their applications and procedures for use.

3. Identify types of portable power tools and describe their applications and procedures for use.

4. Identify types of powder actuated tools and describe their applications.

5. Identify types of shop tools and equipment and describe their applications and procedures for use.

6. Identify types of Computer Numerical Control (CNC) equipment and describe their applications.
   i) plasma cutting
   ii) punches
   iii) brakes

7. Identify types of measuring and layout tools and equipment, and describe their applications and procedures for use.

8. Identify types of welding and cutting equipment and describe their applications.
   i) welding
      - metal
      - non-metal/plastic
   ii) cutting
      - oxy-fuel
      - plasma

9. Identify types of soldering/brazing equipment and describe their applications.

10. Describe the procedures used to inspect, maintain and store tools and equipment.

SMW-115 Ladders and Work Platforms

Learning Outcomes:

- Demonstrate knowledge of ladders and work platforms, their applications, limitations and procedures for use.

Objectives and Content:

1. Define terminology associated with ladders and work platforms.

2. Identify hazards and describe safe work practices pertaining to ladders and work platforms.
   - i) fall protection and arrest
   - ii) power lines
   - iii) excess loads

3. Interpret codes and regulations pertaining to ladders and work platforms.

4. Identify types of ladders and work platforms, and describe their characteristics and applications.
   - i) ladders
   - ii) work platforms
     - stationary
     - portable

5. Describe the procedures used to erect and remove ladders and stationary work platforms.

6. Describe the procedures used to inspect, maintain, transport and store ladders and stationary work platforms.

SMW-120 Metallurgy

Learning Outcomes:

- Demonstrate knowledge of metals and their properties, characteristics and applications.
- Demonstrate knowledge of metallurgic principles.

Objectives and Content:

1. Define terminology associated with metallurgy.

2. Describe the properties of metals.
   - i) ductility
   - ii) malleability
   - iii) elasticity
   - iv) hardness
   - v) composition
   - vi) physical

3. Describe identification systems for metals.
   - i) numbering
   - ii) gauging

4. Identify types of metals and describe their applications.
   - i) steel
     - hot rolled
     - cold rolled
     - coated
   - ii) copper
   - iii) brass
   - iv) aluminum
   - v) cast iron
   - vi) stainless steel

5. Describe the effects metal working has on metallurgic properties.
   - i) stress
   - ii) contraction
   - iii) expansion
   - iv) distortion
   - v) work hardening
   - vi) annealing
   - vii) galvanic action

6. Identify types of basic surface finishes and describe their applications.
   i) mill
   ii) brushed
   iii) mirrored
   iv) dull

7. Identify methods used to work with metals.
   i) forming
   ii) cutting/shearing
   iii) punching
   iv) drilling
   v) joining

8. Identify practices that can create problems when working with metals, and describe the procedures used to prevent or correct these problems.
   i) forming
   ii) cutting/shearing
   iii) punching
   iv) drilling
   v) joining
   vi) storage and handling

SMW-125 Drafting

Learning Outcomes:

- Demonstrate knowledge of basic drafting.
- Demonstrate knowledge of basic drafting tools and equipment and their procedures for use.
- Demonstrate basic knowledge of Computer Aided Drafting (CAD) and its use.

Objectives and Content:

1. Define terminology associated with drafting.

2. Identify basic drafting tools and equipment, and describe their applications and procedures for use.

3. Identify different views used when drafting and describe their applications.
   i) elevation
   ii) plan
   iii) section
   iv) auxiliary

4. Describe the procedures used to develop basic drawings and sketches.
   i) pictorial
   ii) orthographic

SMW-130 Introduction to Gas Metal Arc Welding (GMAW)

Learning Outcomes:

- Demonstrate knowledge of GMAW equipment, its applications and maintenance.
- Demonstrate knowledge of the procedures used to weld mild steel using the GMAW process.

Objectives and Content:

1. Define terminology associated with GMAW.

2. Identify hazards and describe safe work practices pertaining to the use of GMAW equipment.
   - i) personal
   - ii) shop/facility
   - iii) equipment
   - iv) ventilation

3. Interpret codes and regulations pertaining to the use of GMAW equipment for welding mild steel.

4. Describe the GMAW process and its applications.

5. Identify types of GMAW equipment, consumables and accessories used to weld mild steel, and describe their characteristics and applications.

6. Describe the procedures used to set-up, adjust and shut-down GMAW equipment for welding mild steel.

7. Describe the procedures used to maintain and troubleshoot GMAW equipment.

8. Identify the types of welds performed using the GMAW process.
   - i) plug
   - ii) fillet (continuous)
   - iii) stitch
   - iv) tack
   - v) edge
   - vi) corner

9. Describe the procedures used to weld mild steel using the GMAW process.

10. Describe weld defects, their causes and the procedures used to prevent and correct them.
    i) porosity
    ii) cracks
    iii) warping
    iv) undercut

11. Identify weld positions and describe their applications.
    i) flat
    ii) vertical
    iii) horizontal
    iv) overhead

SMW-135 Plasma Arc Cutting

Learning Outcomes:

- Demonstrate knowledge of plasma arc cutting equipment, its maintenance and procedures for use.

Objectives and Content:

1. Define terminology associated with plasma arc cutting.

2. Identify hazards and describe safe work practices pertaining to the use of plasma arc cutting equipment.
   i) personal
   ii) shop/facility
   iii) equipment
   iv) ventilation

3. Interpret codes and regulations pertaining to plasma arc cutting.

4. Identify types of plasma arc cutting equipment and accessories, and describe their applications, limitations and procedures for use.

5. Identify types of consumables and accessories used with plasma arc cutting equipment and describe their applications.

6. Describe the procedures used to set-up, adjust and shut-down plasma arc cutting equipment.

7. Describe the procedures used to maintain and troubleshoot plasma arc cutting equipment.

8. Describe the procedures used to cut material using plasma arc cutting equipment.

9. Describe cutting defects, their causes and the procedures used to prevent and correct them.

SMW-140 Soldering

Learning Outcomes:

- Demonstrate knowledge of materials and equipment used for soldering.
- Demonstrate knowledge of procedures used to solder materials.

Objectives and Content:

1. Define terminology associated with soldering.

2. Identify hazards and describe safe work practices pertaining to the use of soldering equipment.
   i) personal
   ii) shop/facility
   iii) equipment
   iv) ventilation

3. Describe the soldering process and its applications.

4. Identify types of soldering equipment and accessories, and describe their applications and procedures for use.

5. Describe the procedures used to set-up, adjust and shut-down soldering equipment.

6. Describe the procedures used to maintain and troubleshoot soldering equipment.

7. Identify materials used to solder and describe their applications.
   i) fluxes
   ii) solders

8. Describe the procedures used to solder materials.

SMW-145 Pattern Development and Layout

Learning Outcomes:

- Demonstrate knowledge of basic pattern development and layout.
- Demonstrate knowledge of basic geometric shapes.

Objectives and Content:

1. Define terminology associated with pattern development and layout.

2. Identify layout tools and describe their applications and procedures for use.

3. Identify basic geometric shapes and describe their characteristics.

4. Identify layout methods and describe their applications.
   i) simple/straight line
   ii) parallel line
   iii) radial line
   iv) triangulation
   v) computerized
   vi) combination

5. Identify types of computer technology used for pattern development and describe their applications.

SMW-150 Simple Layout

Learning Outcomes:

- Demonstrate knowledge of simple layout, its applications and associated calculations.
- Demonstrate knowledge of basic pattern development using simple layout.

Objectives and Content:

1. Define terminology associated with simple layout.

2. Identify the types of basic patterns and fittings that require simple layout.

3. Identify calculations used in simple layout and describe the procedures used to perform them.

4. Describe the procedures used to develop basic patterns and fabricate fittings using simple layout.
   - i) determine views
   - ii) label lines and points
   - iii) prepare pattern
   - iv) determine types of seams, joints and edges
   - v) calculate allowances
   - vi) determine stretch-outs
   - vii) check pattern accuracy
   - viii) cut pattern
   - ix) label pieces

SMW-155 Fabrication Fundamentals

Learning Outcomes:

- Demonstrate knowledge of the procedures used to fabricate basic ductwork and fittings.

Objectives and Content:

1. Define terminology associated with fabrication.

2. Identify hazards and describe safe work practices associated with fabricating basic sheet metal components.

3. Interpret codes and regulations pertaining to the fabrication of sheet metal components.

4. Interpret information, pertaining to the fabrication of sheet metal components, found on drawings and specifications.

5. Identify tools and equipment used to fabricate basic sheet metal components, and describe their applications and procedures for use.

6. Identify types of fastening methods used to fabricate ductwork and fittings and describe their associated procedures.
   i) mechanical
   ii) adhesives
   iii) welding

7. Identify types of seams for fabrication of ductwork and fittings, and describe the procedures and connectors used to produce them.
   i) longitudinal
      - Pittsburgh Locks
      - groove seams
      - acme locks
      - snap/button locks
   ii) transverse
      - slip & drive
      - duct mate
      - TDC/TDF
      - companion flanges
      - flexible connectors

8. Identify types of edges for fabrication of ductwork and fittings, and describe the procedures used to produce them.

9. Identify types of duct reinforcement.

SMW-160 Fastening and Retaining Devices

Learning Outcomes:

- Demonstrate knowledge of fastening and retaining devices and their applications.
- Demonstrate knowledge of the procedures to install and remove fastening and retaining devices.

Objectives and Content:

1. Define terminology associated with fastening and retaining devices.

2. Identify hazards and describe safe work practices pertaining to the installation and removal of fastening and retaining devices.

3. Identify tools and equipment used to install, remove and repair fastening and retaining devices, and describe their applications and procedures for use.

4. Identify types of fastening devices and materials, and describe their characteristics and applications.
   i) mechanical
   ii) adhesives

5. Describe the procedures used to install, remove and repair fastening devices.

6. Describe the purpose and procedures associated with torquing fastening devices.

7. Identify types of retaining devices, and describe their characteristics and applications.

8. Describe the procedures used to install and remove retaining devices.

9. Identify thread classifications and describe the procedures used for thread identification.

SMW-165 Resistance Spot Welding

Learning Outcomes:

- Demonstrate knowledge of resistance spot welding equipment, consumables and accessories.
- Demonstrate knowledge of the procedures used to set-up, adjust, operate, inspect and maintain resistance spot welding equipment.

Objectives and Content:

1. Define terminology associated with resistance spot welding.

2. Identify hazards and describe safe work practices pertaining to resistance spot welding.

3. Interpret information pertaining to resistance spot welding found on drawings and specifications.

4. Describe the resistance spot welding process and its applications.

5. Identify resistance spot welding equipment and accessories, and describe their applications.

6. Identify considerations when determining resistance spot welding equipment set-up.
   - i) specification requirements
   - ii) base metal
     - properties
     - thickness
   - iii) electrode size

7. Describe the procedures used to set-up and adjust resistance spot welding equipment.
   - i) set time
   - ii) determine amperage
   - iii) adjust pressure

8. Describe the procedures used to inspect and maintain resistance spot welding equipment.

9. Describe the procedures used to prepare base metals for resistance spot welding.

10. Describe the procedures used to weld using the resistance spot welding process.

LEVEL 2

SMW-205 Hoisting, Lifting and Rigging

Learning Outcomes:

- Demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use.
- Demonstrate knowledge of basic hoisting, lifting and rigging techniques.
- Demonstrate knowledge of the procedures used to perform hoisting and lifting operations.
- Demonstrate knowledge of calculations required when performing hoisting and lifting operations.

Objectives and Content:

1. Define terminology associated with hoisting, lifting and rigging.

2. Identify hazards and describe safe work practices pertaining to hoisting, lifting and rigging.

3. Interpret codes and regulations pertaining to rigging, hoisting and lifting.
   i) training and certification requirements

4. Identify types of rigging equipment and accessories, and describe their applications, limitations and procedures for use.
   i) ropes
   ii) slings
   iii) chains
   iv) hooks
   v) spreader bars
   vi) shackles

5. Identify the factors to consider when selecting rigging equipment.
   i) load characteristics
   ii) environment
   iii) safety factor

6. Identify the factors to consider when rigging material/equipment for lifting.
   i) load characteristics
   ii) equipment and accessories
   iii) environmental factors
   iv) anchor points
   v) sling angles

7. Identify types of knots, hitches, splices and bends, and describe the procedures used to tie them.
   i) bowline
   ii) running bowline
   iii) square/reef
   iv) half-hitch

8. Identify types of hoisting and lifting equipment and accessories, and describe their applications and procedures for use.
   i) duct lift
   ii) electric overhead travelling cranes
   iii) come-alongs
   iv) tirfors
   v) chainfalls

9. Describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment.

10. Explain sling angle when preparing for hoisting and lifting operations.

11. Describe the procedures used for attaching rigging equipment to the load.

12. Identify and interpret basic hand signals used for hoisting and lifting.

13. Describe the procedures used to communicate during hoisting, lifting and rigging operations.
   i) hand signals
   ii) electronic communications
   iii) audible/visual

14. Describe the procedures used to ensure the work area is safe for lifting.
   i) supervision of lift
   ii) securing work area
   iii) communication

15. Describe the procedures used to perform a lift.
   i) load determination
   ii) communication methods

iii) pre-lift checks
iv) placement of load
v) post-lift inspection

16. Describe the procedures used to perform calculations to determine the weight of a load.

SMW-210 Drawings and Specifications

Learning Outcomes:

- Demonstrate knowledge of drawings and specifications, and their applications.
- Demonstrate knowledge of the procedures used to interpret and extract information from drawings.

Objectives and Content:

1. Define terminology associated with drawings and specifications.

2. Identify the types of drawings and describe their applications.
   - i) civil/site
   - ii) architectural
   - iii) mechanical
   - iv) structural
   - v) electrical
   - vi) shop drawings
   - vii) sketches
   - viii) as-built

3. Identify the views used on drawings.
   - i) elevation
   - ii) plan
   - iii) section
   - iv) detail
   - v) auxiliary

4. Identify the parts of a drawing, and describe their purpose and applications.
   - i) lines
   - ii) legend
   - iii) symbols and abbreviations
     - duct
     - welding
     - electrical
     - plumbing
     - architectural
   - iv) title block
   - v) notes
   - vi) specifications

5. Identify and interpret common symbols and abbreviations found on drawings.

6. Identify the types of scales and describe their applications and procedures for use.

7. Describe metric and imperial systems of measurement.

8. Interpret and extract information from drawings.

SMW-215 Parallel Line Development (Round Duct Fittings)

Learning Outcomes:

- Demonstrate knowledge of parallel line development, its applications and associated calculations.
- Demonstrate knowledge of the procedures used to develop and fabricate round duct fittings using parallel line development.

Objectives and Content:

1. Define terminology associated with parallel line development.

2. Describe the types of round duct fittings that require parallel line development.
   i) tee
   ii) round elbow
   iii) round offsets

3. Identify calculations used in parallel line development and describe the procedures used to perform them.

4. Describe the procedures used to develop and fabricate round duct fittings using parallel line development.
   i) determine views
   ii) label lines and points
   iii) prepare pattern
   iv) determine true length of lines
   v) determine types of seams, joints and edges
   vi) calculate allowances
   vii) determine stretch-outs
   viii) check pattern accuracy
   ix) cut pattern
   x) label pieces

SMW-220 Radial Line Development (Right Cones)

Learning Outcomes:

- Demonstrate knowledge of radial line development, its applications and associated calculations.
- Demonstrate knowledge of the procedures used to develop and fabricate right cones using radial line development.

Objectives and Content:

1. Define terminology associated with radial line development.

2. Identify calculations used in radial line development and describe the procedures used to perform them.

3. Describe the procedures used to develop and fabricate fittings based on right cones using radial line development.
   - i) determine views
   - ii) label lines and points
   - iii) prepare pattern
   - iv) determine true length of lines
   - v) determine types of seams, joints and edges
   - vi) calculate allowances
   - vii) determine stretch-outs
   - viii) check pattern accuracy
   - ix) cut pattern
   - x) label pieces

SMW-225 Triangulation (From Plan View)

Learning Outcomes:

- Demonstrate knowledge of triangulation, its applications and associated calculations.
- Demonstrate knowledge of the procedures used to develop and fabricate fittings using triangulation from plan view.

Objectives and Content:

1. Define terminology associated with the triangulation method.

2. Describe the types of fittings that require triangulation from plan view.
   i) transitions
   ii) tapers
   iii) square-to-rounds

3. Identify calculations used in the triangulation method and describe the procedures used to perform them.

4. Describe the procedures used to develop and fabricate fittings using triangulation from plan view.
   i) determine views
   ii) label lines and points
   iii) prepare pattern
   iv) determine true length of lines
   v) determine types of seams, joints and edges
   vi) calculate allowances
   vii) determine stretch-outs
   viii) check pattern accuracy
   ix) cut pattern
   x) label pieces

SMW-230 Advanced Gas Metal Arc Welding (GMAW)

Learning Outcomes:

- Demonstrate knowledge of the procedures used to weld aluminum and stainless steel using the GMAW process.
- Demonstrate knowledge of the procedures used to weld mild and galvanized steel using the FCAW process.

Objectives and Content:

1. Interpret codes and regulations pertaining to the use of GMAW equipment for welding aluminum and stainless steel.

2. Identify GMAW equipment, consumables and accessories used to weld aluminum and stainless steel, and describe their characteristics and applications.

3. Identify the modes of transfer relating to GMAW welding and describe their characteristics and applications.
   i) short circuiting
   ii) globular
   iii) spray
   iv) pulse

4. Describe the procedures used to set-up, adjust and shut-down GMAW equipment for welding aluminum and stainless steel.

5. Describe the procedures used to weld aluminum and stainless steel using the GMAW process.
   i) plug
   ii) fillet (continuous)
   iii) stitch
   iv) tack
   v) edge
   vi) corner

6. Describe weld defects, their causes and the procedures used to prevent and correct them.
   i) porosity
   ii) cracks
   iii) warping
   iv) undercut

7. Identify FCAW equipment, consumables and accessories used to weld mild and galvanized steel, and describe their characteristics and applications.

8. Describe the procedures used to set-up, adjust and shut-down FCAW equipment for welding mild and galvanized steel.

9. Describe the procedures used to weld mild and galvanized steel using the FCAW process.
   - i) plug
   - ii) fillet (continuous)
   - iii) stitch
   - iv) tack
   - v) edge
   - vi) corner

SMW-235 Introduction to Gas Tungsten Arc Welding (GTAW)

Learning Outcomes:

- Demonstrate knowledge of GTAW equipment, its applications and maintenance.
- Demonstrate knowledge of the procedures used to weld mild steel using the GTAW process.

Objectives and Content:

1. Define terminology associated with GTAW.

2. Identify hazards and describe safe work practices pertaining to the use of GTAW equipment.
   i) personal
   ii) shop/facility
   iii) equipment
   iv) ventilation

3. Interpret codes and regulations pertaining to the use of GTAW equipment for welding mild steel.

4. Interpret information, pertaining to the use of GTAW equipment, found on drawings and specifications.

5. Describe the GTAW process and its applications.

6. Identify GTAW equipment, consumables and accessories used to weld mild steel, and describe their characteristics and applications.

7. Describe the procedures used to set-up, adjust and shut-down GTAW equipment for welding mild steel.

8. Describe the procedures used to maintain and troubleshoot GTAW equipment.

9. Identify the types of welds performed using the GTAW process.
   i) plug
   ii) fillet (continuous)
   iii) stitch
   iv) tack
   v) edge
   vi) corner

10. Describe the procedures used to weld mild steel using the GTAW process.

11. Describe weld defects, their causes and the procedures used to prevent and correct them.
    i) porosity
    ii) cracks
    iii) warping
    iv) undercut

SMW-240 Fabrication (Air Handling Systems and Components)

Learning Outcomes:

- Demonstrate knowledge of sheet metal components for air handling systems and the procedures used to fabricate them.

Objectives and Content:

1. Define terminology associated with air handling systems.

2. Identify hazards and describe safe work practices when fabricating sheet metal components for air handling systems.

3. Interpret codes and regulations pertaining to the fabrication of sheet metal components for air handling systems.
   i) Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
   ii) American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
   iii) National Building Code (NBC)

4. Interpret information, pertaining to the fabrication of sheet metal components for air handling systems, found on drawings and specifications.

5. Identify tools and equipment used to fabricate sheet metal components for air handling systems, and describe their applications, limitations and procedures for use.

6. Identify types of materials used to fabricate sheet metal components for air handling systems, and describe their characteristics and applications.

7. Identify and describe sheet metal components associated with air handling systems.
   i) ductwork
   ii) fittings
   iii) dampers
   iv) fire dampers
   v) flexible connections
   vi) hangers
   vii) equipment supports/bases
   viii) louvers
   ix) attenuators (silencers)

8. Identify considerations and requirements when fabricating sheet metal components for air handling systems.
   i) load bearing capacities
   ii) system specifications
   iii) environmental conditions

9. Describe the procedures used to fabricate sheet metal components for air handling systems.
   i) cut
   ii) label
   iii) form
   iv) insulate
   v) assemble

SMW-245 Installation (Air Handling Systems)

Learning Outcomes:

- Demonstrate knowledge of installation procedures for air handling systems and their components.
- Demonstrate knowledge of basic design and field modifications.

Objectives and Content:

1. Define terminology associated with the installation of air handling systems and components.

2. Identify hazards and describe safe work practices pertaining to the installation of air handling systems and components.

3. Interpret codes and regulations pertaining to the installation of air handling systems and components.

4. Interpret information, pertaining to the installation of air handling systems, found on drawings and specifications.

5. Identify tools and equipment used for the installation of air handling systems, and describe their application, limitations and procedures for use.

6. Identify types of air handling systems, and describe their applications, principles and operation.
   - i) exhaust
   - ii) make-up air
   - iii) supply/return air (central)

7. Identify air handling system components and describe their applications.
   - i) sheet metal components
     - ductwork
     - fittings
     - hangers
     - braces
     - brackets
     - cladding/lagging
     - flashing
   - ii) system components
     - units
     - dampers

- fire dampers
- registers/diffusers
- grilles
- louvers
- coils
- heat and energy recovery ventilators
- automatic controls and instruments
- insulation
    - thermal
    - acoustical

iii) accessories
- humidifiers
- filters
- mixing boxes

8. Identify the types of fasteners and describe their applications.
   i) concrete
   ii) metal
   iii) wood

9. Describe the procedures used to prepare for installation of residential and commercial/industrial air handling systems and components.
   i) determine equipment requirements
   ii) determine penetration locations
   iii) perform site measurements
   iv) demolition and removal of existing systems and components
   v) on-site co-ordination
      - staging (storing material)
      - planning
      - distributing (material to installation area)
      - sectioning (pre-assembling on site)
      - erecting
   vi) final inspection (completing)

10. Identify considerations and requirements for installing air handling system components.
   i) manufacturers' specifications
   ii) isolators
   iii) building materials
   iv) environmental conditions
   v) field design modifications

11. Describe the procedures used to install air handling system components.

LEVEL 3

SMW-300 Advanced Gas Tungsten Arc Welding (GTAW)

Learning Outcomes:

- Demonstrate knowledge of the procedures used to weld aluminum, stainless steel and copper using the GTAW process.

Objectives and Content:

1. Interpret codes and regulations pertaining to the use of GTAW equipment for welding aluminum, stainless steel and copper.

2. Identify types of GTAW equipment, consumables and accessories used to weld aluminum, stainless steel and copper, and describe their characteristics and applications.

3. Describe the procedures used to set-up, adjust and shut-down GTAW equipment for welding aluminum, stainless steel and copper.

4. Describe the procedures used to weld aluminum, stainless steel and copper using the GTAW process.
   i) plug
   ii) fillet (continuous)
   iii) stitch
   iv) tack
   v) edge
   vi) corner

5. Describe weld defects, their causes and the procedures used to prevent and correct them.
   i) porosity
   ii) cracks
   iii) warping
   iv) undercut

SMW-310 Parallel Line Development (Architectural Applications)

Learning Outcomes:

- Demonstrate knowledge of parallel line development for architectural applications and its associated calculations.
- Demonstrate knowledge of the procedures used to develop and fabricate advanced or complex fittings for architectural applications using parallel line development.

Objectives and Content:

1. Define terminology associated with parallel line development for architectural applications.

2. Identify the types of fittings and components for architectural applications that require parallel line development.
   i) copings
   ii) gutters
   iii) mitred flashings

3. Identify calculations used in parallel line development for architectural applications and describe the procedures used to perform them.

4. Describe the procedures used to develop and fabricate fittings and components for architectural applications using parallel line development.
   i) determine views
   ii) label lines and points
   iii) prepare pattern
   iv) determine true length of lines
   v) determine types of seams, joints and edges
   vi) calculate allowances
   vii) determine stretch-outs
   viii) check pattern accuracy
   ix) cut pattern
   x) label pieces

SMW-315 Radial Line Development (Oblique Fittings)

Learning Outcomes:

- Demonstrate knowledge of radial line development for oblique fittings and its associated calculations.
- Demonstrate knowledge of the procedures used to develop and fabricate oblique fittings using radial line development.

Objectives and Content:

1. Define terminology associated with radial line development for oblique fittings.

2. Identify the types of oblique fittings and components that require radial line development.
   i) round reducer with apex outside the base

3. Identify calculations used in radial line development for oblique fittings and describe the procedures used to perform them.

4. Describe the procedures used to develop and fabricate oblique fittings and components using radial line development.
   i) determine views
   ii) label lines and points
   iii) prepare pattern
   iv) determine true length of lines
   v) determine types of seams, joints and edges
   vi) calculate allowances
   vii) determine stretch-outs
   viii) check pattern accuracy
   ix) cut pattern
   x) label pieces

SMW-320 Triangulation (From Elevation)

Learning Outcomes:

- Demonstrate knowledge of triangulation from elevation, its applications and associated calculations.
- Demonstrate knowledge of the procedures used to develop and fabricate advanced or complex fittings using triangulation from elevation.

Objectives and Content:

1. Define terminology associated with the triangulation method from elevation.

2. Identify the types of fittings and components that require triangulation from elevation.

3. Identify calculations used in the triangulation method from elevation and describe the procedures used to perform them.

4. Describe the procedures used to develop and fabricate fittings and components using triangulation from elevation.
   - i) determine views
   - ii) label lines and points
   - iii) prepare pattern
   - iv) determine true length of lines
   - v) determine types of seams, joints and edges
   - vi) calculate allowances
   - vii) determine stretch-outs
   - viii) check pattern accuracy
   - ix) cut pattern
   - x) label pieces

SMW-325 Duct System Design

Learning Outcomes:

- Demonstrate knowledge of duct systems and their associated design principles.

Objectives and Content:

1. Define terminology associated with duct system design.

2. Identify the types of basic duct systems and describe their associated design principles.
   - i) air handling systems
     - single path
     - variable air volume (VAV)
   - ii) material handling systems
     - positive
     - negative

3. Describe the procedures used to perform heat gain/loss calculations and their applications.

4. Identify air patterns and describe their impact on the operation of duct systems.

5. Explain air pressure and its impact on the operation of duct systems.

6. Identify formulas used in duct system design and describe their applications.
   - i) fan laws
   - ii) velocity
   - iii) quantity
   - iv) pressure

7. Identify considerations and requirements used to determine duct system design.
   - i) equal friction
     - air duct calculator
   - ii) static regain
   - iii) constant velocity

SMW-330 Air Quality Management

Learning Outcomes:

- Demonstrate knowledge of air quality management.

Objectives and Content:

1. Define terminology associated with air quality management.

2. Identify hazards and describe safe work practices pertaining to air quality management.

3. Interpret codes and regulations pertaining to air quality management.

4. Identify considerations and requirements associated with air quality management.
   i) environmental conditions
   ii) intake locations
   iii) exhaust locations

5. Explain the importance of indoor air quality.

6. Identify methods of improving or correcting problems with air quality.
   i) heating/cooling
   ii) ventilation
   iii) conditioning
      - filtration
      - sterilization
      - purification
      - humidification/dehumidification

7. Identify areas requiring special air quality ventilation.
   i) clean/sterile rooms
   ii) industrial/commercial settings

8. Identify the methods used to determine air quality relating to humidity and temperature.

9. Identify air quality problems and describe the procedures used to prevent or correct them.
   i) contamination
   ii) humidity
   iii) temperature (hot/cold zones)
   iv) air motion

10. Describe the impact improper system or component installation can have on air quality.

SMW-335 Chimneys, Breeching and Venting

Learning Outcomes:

- Demonstrate knowledge of installation procedures for chimneys, breeching and venting.

Objectives and Content:

1. Define terminology associated with chimneys, breeching and venting.

2. Identify hazards and describe safe work practices associated with chimneys, breeching and venting.

3. Interpret codes, standards and regulations pertaining to the installation of chimneys, breeching and venting.
   i) jurisdictional requirements

4. Interpret information pertaining to the installation of chimneys, breeching and venting, found on drawings and specifications.

5. Identify tools and equipment relating to the installation of chimneys, breeching and venting, and describe their applications and procedures for use.

6. Identify types of chimneys, breeching and venting systems and their components, and describe their applications.
   i) chimney classifications
   ii) vent classifications/combustion air

7. Describe the procedures used to remove and install chimneys, breeching and venting.

8. Describe the procedures used to connect chimneys, breeching and venting to the appliance.

9. Identify cladding and lagging materials used for chimneys, breeching, and venting and describe their characteristics and applications.

10. Identify flashing requirements pertaining to chimneys, breeching and venting.

11. Describe the procedures used to install cladding and lagging on chimneys, breeching and venting.

LEVEL 4

SMW-400 Fabrication (Material Handling Systems and Components)

Learning Outcomes:

- Demonstrate knowledge of sheet metal components for material handling systems and the procedures used to fabricate them.

Objectives and Content:

1. Define terminology associated with material handling systems.

2. Identify hazards and describe safe work practices when fabricating sheet metal components for material handling systems.

3. Interpret codes and regulations pertaining to the fabrication of sheet metal components for material handling systems.
   i) Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
   ii) American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
   iii) National Building Code (NBC)

4. Interpret information, pertaining to the fabrication of sheet metal components for material handling systems, found on drawings and specifications.

5. Identify tools and equipment used to fabricate sheet metal components for material handling systems, and describe their applications, limitations and procedures for use.

6. Identify types of materials used to fabricate sheet metal components for material handling systems, and describe their characteristics and applications.

7. Identify and describe sheet metal components associated with material handling systems.
   i) ductwork
   ii) fittings
   iii) dampers
   iv) fire dampers
   v) flexible connections
   vi) hangers
   vii) equipment supports/bases
   viii) louvers
   ix) attenuators (silencers)

8. Identify considerations and requirements when fabricating sheet metal components for material handling systems.
   i) load bearing capacities
   ii) system specifications
   iii) environmental conditions
   iv) architectural conditions

9. Describe the procedures used to fabricate sheet metal components for material handling systems.
   i) cut
   ii) label
   iii) form
   iv) insulate
   v) assemble

SMW-405 Installation (Material Handling Systems)

Learning Outcomes:

- Demonstrate knowledge of installation procedures for material handling systems and their components.
- Demonstrate knowledge of basic design and field modifications.

Objectives and Content:

1. Define terminology associated with the installation of material handling systems and components.

2. Identify hazards and describe safe work practices pertaining to the installation of material handling systems and components.

3. Interpret codes and regulations pertaining to the installation of material handling systems and components.

4. Interpret information, pertaining to the installation of material handling systems, found on drawings and specifications.

5. Identify tools and equipment used for the installation of material handling systems, and describe their applications, limitations and procedures for use.

6. Identify types of material handling systems and describe their applications, principles and operation.
   i) conveyors
   ii) chutes
   iii) blow pipe/dust collection

7. Identify material handling system components and describe their applications.
   i) sheet metal components
      - ductwork
      - fittings
      - hangers
      - braces
      - brackets
      - cladding/lagging
      - flashing
   ii) system components
      - fans
      - collection devices

- cyclone
- separating devices
- automatic controls and instruments
- thermal insulation

iii) accessories
- access doors
- blast gates

8. Identify the types of fasteners and describe their applications.
   i) concrete
   ii) metal
   iii) wood

9. Describe the procedures used to prepare for the installation of material handling system components.
   i) determine equipment requirements
   ii) verify duct sizing
   iii) determine penetration locations
   iv) perform site measurements
   v) demolish and remove existing systems and components
   vi) perform on-site co-ordination
   - staging (storing material)
   - planning
   - distributing (material to installation area)
   - sectioning (pre-assembling on-site)
   - erecting

   vii) complete final inspection

10. Identify considerations when installing material handling system components.
   i) manufacturers' specifications
   ii) isolators
   iii) building materials
   iv) environmental conditions
   v) field design modifications

11. Describe the procedures used to install material handling system components.

SMW-410 Maintenance and Repair (Air and Material Handling Systems)

Learning Outcomes:

- Demonstrate knowledge of maintenance and repair procedures for air handling systems.
- Demonstrate knowledge of maintenance and repair procedures for material handling systems.
- Demonstrate knowledge of testing devices and their applications.

Objectives and Content:

1. Define terminology associated with the maintenance and repair of air and material handling systems.

2. Identify hazards and describe safe work practices pertaining to the maintenance and repair of air and material handling systems.

3. Interpret codes and regulations pertaining to the maintenance and repair of air and material handling systems.
   i) Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
   ii) American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
   iii) National Building Code (NBC)

4. Identify tools and equipment used to maintain and repair air and material handling system components, and describe their applications, limitations and procedures for use.
   i) testing devices

5. Identify considerations for the maintenance and repair of air and material handling system components.
   i) sounds
   ii) vibration
   iii) odours
   iv) heat build-up
   v) visual

6. Describe the procedures used to diagnose system faults in air and material handling system components.

7. Describe the procedures used to service air and material handling system components.
   i) scheduled
      - filters
      - lubrication
      - adjustments
   ii) emergency
   iii) lock-out

8. Describe the procedures used to repair or replace worn, faulty or defective components of air and material handling systems.

SMW-415 Testing, Adjusting and Balancing (Air and Material Handling Systems)

Learning Outcomes:

- Demonstrate knowledge of testing, adjusting and balancing procedures for air handling systems.
- Demonstrate knowledge of testing, adjusting and balancing procedures for material handling systems.

Objectives and Content:

1. Define terminology associated with testing, adjusting and balancing air and material handling systems.

2. Identify hazards and describe safe work practices pertaining to testing, adjusting and balancing air and material handling systems.

3. Interpret codes and regulations pertaining to testing, adjusting and balancing air and material handling systems.

4. Interpret information, pertaining to testing, adjusting and balancing air and material handling systems, found on drawings and specifications.

5. Identify requirements and limitations pertaining to testing, adjusting and balancing air handling systems.

6. Identify tools and instruments used in testing, adjusting and balancing systems, and describe their applications and procedures for use.
   - i) electrical devices
   - ii) air balancing devices
   - iii) charts
     - psychometric
     - fan

7. Explain the importance of testing, balancing and adjusting to ensure optimal system performance.

8. Identify types of tests relating to air and material handling system components and describe the procedures used to perform them.
   - i) leak/pressure test

9. Describe the procedures and techniques used to perform balancing on air handling systems.

10. Describe the procedures and techniques used to perform balancing on material handling systems.

11. Describe the procedures used to adjust air handling system components to optimize performance.

12. Describe the procedures used to adjust material handling system components to optimize performance.

13. Identify problems pertaining to air handling systems and describe the procedures used to prevent and correct them.
    - i) positive pressure
    - ii) negative pressure
    - iii) improper installation
        - duct sizing
        - noise

14. Identify problems pertaining to material handling systems and describe the procedures used to prevent and correct them.

SMW-420 Metal Roofing and Architectural Metal

Learning Outcomes:

- Demonstrate knowledge of fabrication procedures for metal roofing, cladding and architectural metals.
- Demonstrate knowledge of installation procedures for metal roofing, cladding and architectural metals.

Objectives and Content:

1. Define terminology associated with metal roofing, cladding and architectural metals.

2. Identify hazards and describe safe work practices pertaining to the fabrication and installation of metal roofing, cladding and architectural metals.

3. Interpret codes and regulations pertaining to the installation of metal roofing, cladding and architectural metals.

4. Interpret information, pertaining to metal roofing, cladding and architectural metal, found on drawings and specifications.

5. Identify tools and equipment used to fabricate and install metal roofing, cladding and architectural metals, and describe their applications and procedures for use.

6. Identify types of materials used in fabricating metal roofing, cladding and architectural metals.

7. Identify types of components associated with metal roofing, cladding and architectural metals, and describe their applications.
   i) roof drainage
   ii) flashing
   iii) soffit and fascia
   iv) roof vents

8. Describe the procedures used to fabricate metal roofing, cladding and architectural metals and their associated components.
   i) layout
   ii) determine seam
   iii) cut
   iv) form

9. Identify considerations and requirements relating to the installation of metal roofing, cladding and architectural metals.
   i) building materials
   ii) roof slope
   iii) expansion and contraction

10. Identify types of fasteners for installing metal roofing, cladding and architectural metals and describe their applications.

11. Identify types of roof structures and construction features and describe their applications.
   i) hip
   ii) gable
   iii) pitched
   iv) flat

12. Describe the procedures used to layout metal roofing, cladding and architectural metals.
   i) check for square
   ii) determine starting point
   iii) establish reference lines

13. Identify materials to be installed to prepare surfaces for installation of metal roofing, cladding and architectural metals.
   i) insulation
   ii) waterproof membrane
   iii) isolation material
   iv) building envelope

14. Describe the procedures used to install materials to roofs or walls in preparation for installation of metal roofing, cladding and architectural metals.

15. Describe the procedures used to install metal roofing, cladding and architectural metals.
   i) cut
   ii) fit
   iii) secure
   iv) seal

16. Identify types of metal decking and describe their applications.
   i) metal pan
   ii) Q decking

17. Describe the procedures used to install decking.

18. Identify types of exterior components and describe their applications.
    i) awnings
    ii) signage

SMW-425 Shielded Metal Arc Welding (SMAW)

Learning Outcomes:

- Demonstrate knowledge of SMAW equipment, its applications, maintenance and procedures for use.
- Demonstrate knowledge of weld defects, their causes and the procedures used to prevent and correct them.

Objectives and Content:

1. Define terminology associated with SMAW.

2. Identify hazards and describe safe work practices pertaining to the use of SMAW equipment.
   i) personal
   ii) shop/facility
   iii) equipment
   iv) ventilation

3. Interpret codes and regulations pertaining to the SMAW process.

4. Interpret information, pertaining to the SMAW process, found on drawings and specifications.

5. Describe the SMAW process and its applications.

6. Identify types of SMAW equipment and accessories, and describe their applications, limitations and procedures for use.

7. Describe the procedures to set-up, adjust and shut-down SMAW equipment.

8. Describe the procedures used to maintain and troubleshoot SMAW equipment.

9. Identify the types of welds performed using SMAW equipment.
   i) plug
   ii) fillet (continuous)
   iii) stitch
   iv) tack
   v) edge
   vi) corner

10. Describe the procedures used to weld materials using the SMAW process.

11. Describe weld defects, their causes and the procedures used to prevent and correct them.
    i) porosity
    ii) cracks
    iii) warping
    iv) undercut

SMW-430 Oxy-fuel Cutting, Heating and Brazing/Hard Soldering

Learning Outcomes:

- Demonstrate knowledge of oxy-fuel cutting and heating equipment, its maintenance and procedures for use.
- Demonstrate knowledge of brazing/hard soldering equipment, its maintenance and procedures for use.

Objectives and Content:

1. Define terminology associated with oxy-fuel cutting, heating and brazing/hard soldering.

2. Identify hazards and describe safe work practices pertaining to the use of oxy-fuel cutting, heating and brazing/hard soldering equipment.
   i) personal
   ii) shop/facility
   iii) equipment
   iv) ventilation

3. Interpret codes and regulations pertaining to oxy-fuel cutting, heating and brazing/hard soldering.

4. Interpret information, pertaining to oxy-fuel cutting, heating and brazing/hard soldering, found on drawings and specifications.

5. Identify the types of oxy-fuel cutting, heating and brazing/hard soldering equipment and accessories, and describe their applications, limitations and procedures for use.

6. Describe the procedures used to set-up, adjust and shut-down oxy-fuel cutting and heating equipment.

7. Describe the procedures used to maintain and troubleshoot oxy-fuel cutting and heating equipment.

8. Describe the procedures used to set-up, adjust, and shut-down brazing/hard soldering equipment.

9. Describe the procedures used to maintain and troubleshoot brazing/hard soldering equipment.

10. Describe the procedures used to cut using oxy-fuel equipment.

11. Identify types of materials used for brazing/hard soldering.

12. Describe the procedures used to braze/hard solder materials.

13. Describe weld defects, their causes and the procedures used to prevent and correct them.
    i) porosity
    ii) cracks
    iii) warping
    iv) undercut

SMW-435 Specialty Products

Learning Outcomes:

- Demonstrate knowledge of specialty products and their applications.
- Demonstrate knowledge of fabrication procedures for specialty products.
- Demonstrate knowledge of installation procedures for specialty products and their related components.

Objectives and Content:

1. Define terminology associated with specialty products.
   i) metal
   ii) non-metal

2. Identify hazards and safe work practices pertaining to the fabrication and installation of specialty products.

3. Interpret codes and regulations pertaining to the fabrication and installation of specialty products.
   i) manufacturers' specifications
   ii) environmental conditions
   iii) sanitation

4. Interpret information, pertaining to the fabrication and installation of specialty products, found on drawings and specifications.

5. Identify tools and equipment used to fabricate and install specialty products, and describe their applications, limitations and procedures for use.

6. Identify types of specialty products and accessories, and describe their applications.
   i) kitchen
   ii) medical
   iii) food processing
   iv) pharmaceutical laboratory
   v) decorative

7. Identify types of materials used in fabricating specialty products and components, and describe their applications.
   i) ferrous
   ii) non-ferrous
   iii) plastics/polyvinyl chloride (PVC)
   iv) composites (awnings)

8. Describe the procedures used to fabricate specialty products and their associated components.
   i) handle
   ii) design
   iii) cut
   iv) form
   v) assemble
   vi) join
   vii) finish

9. Identify types of fasteners and fastening methods used to install specialty products and describe their applications.

10. Describe the procedures used to install specialty products.

SMW-440 Trade Related Documents

Learning Outcomes:

- Demonstrate knowledge of trade related documents and their use.
- Demonstrate knowledge of procedures used to prepare documentation.

Objectives and Content:

1. Identify types of trade related documents and describe their applications.
   - i) manufacturers' specifications
   - ii) drawings and specifications
   - iii) codes and standards
     - Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
     - American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
     - National Building Code (NBC)
   - iv) work orders
     - change
     - job
     - material

2. Identify types of documentation and describe the procedures used to prepare them.
   - i) work orders
   - ii) reports
     - hazard assessment
     - safety
     - Worker's Compensation
   - iii) maintenance/service records
   - iv) stock/inventory records
     - shop
     - job site
     - vehicle

SMW-445 Job Planning

Learning Outcomes:

- Demonstrate knowledge of the procedures used to plan and organize jobs.
- Demonstrate knowledge of the procedures used to take field measurements.
- Demonstrate knowledge of the procedures used to produce material take-off lists.

Objectives and Content:

1. Identify sources of information relevant to job planning.
   - i) documentation
   - ii) drawings
   - iii) specifications
   - iv) related professionals
   - v) clients

2. Identify considerations for determining job requirements.
   - i) personnel
   - ii) tools and equipment
   - iii) materials
   - iv) permits

3. Describe the procedures used to plan job tasks.
   - i) scheduling
   - ii) estimating

4. Describe the procedures used to organize and maintain inventory.

5. Describe the procedures used to interpret and extract information from blueprints.

6. Explain the purpose of submittals and shop drawings, and describe the procedures used to interpret them.

7. Describe the procedures used to take field measurements.

8. Identify the types of material take-off lists, and describe their applications and the procedures used to produce them.
   - i) material estimation
   - ii) material installation

SMW-450 Electrical Principles

Learning Outcomes:

- Demonstrate knowledge of the basic concepts of electricity.
- Demonstrate knowledge of electrical components and equipment.

Objectives and Content:

1. Define terminology associated with electricity.

2. Explain the basic principles of electricity.

3. Explain the mathematical relationship between amps, volts, ohms and watts.

4. Identify hazards and describe safe work practices pertaining to working on or around electrical equipment and sources.

5. Identify electrical devices and describe their purpose.
   i) circuit breakers
   ii) disconnects
   iii) overload heaters
   iv) ground fault interrupters (GFI)
   v) fuses
   vi) programmable logic controllers (PLC)
   vii) motors

6. Identify the types of electrical test meters, and describe their applications and procedures for use.