



**ONTARIO COLLEGE OF TRADES**  
**ORDRE DES MÉTIERS DE L'ONTARIO**

Apprenticeship  
Curriculum Standard

Sheet Metal Worker

Levels 1, 2 and 3

Trade Code: 308A

Development Date: 2003



**Please Note:**

Apprenticeship Training and Curriculum Standards were developed by the Ministry of Training, Colleges and Universities (MTCU). As of April 8<sup>th</sup>, 2013, the Ontario College of Trades (College) has become responsible for the development and maintenance of these standards. The College is carrying over existing standards without any changes.

However, because the Apprenticeship Training and Curriculum Standards documents were developed under either the *Trades Qualification and Apprenticeship Act* (TQAA) or the *Apprenticeship and Certification Act, 1998* (ACA), the definitions contained in these documents may no longer be accurate and may not be reflective of the *Ontario College of Trades and Apprenticeship Act, 2009* (OCTAA) as the new trades legislation in the province. The College will update these definitions in the future.

Meanwhile, please refer to the College's website ([www.collegeoftrades.ca](http://www.collegeoftrades.ca)) for the most accurate and up-to-date information about the College. For information on OCTAA and its regulations, please visit: [www.collegeoftrades.ca/about/legislation-and-regulations](http://www.collegeoftrades.ca/about/legislation-and-regulations).

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## **Introduction**

This new curriculum standard for the Sheet Metal Worker trade is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 15 reportable subjects. The Program Summary of Reportable Subjects chart summarizes the training hours for each reportable subject.

The curriculum identifies only the learning that takes place off-the-job. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards. Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on the work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to ensure that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

**PROGRAM SUMMARY OF REPORTABLE SUBJECTS**

<b>Number</b>	<b>Reportable Subjects</b>	<b>Hours Total</b>	<b>Hours Theory</b>	<b>Hours Practical</b>
<b>LEVEL 1</b>				
S1701	Fabricates for Shop and Field	54	42	12
S1702	Use and Maintain Hand/Power Tools and Shop Equipment	36	24	12
S1703	Lay-out and Drafting 1	99	60	39
S1704	Read, Interpret and Produce Drawings	27	27	0
S1705	Weld and Cut 1	24	9	15
	<b>Sub-Totals for Level 1</b>	<b>240</b>	<b>162</b>	<b>78</b>
<b>LEVEL 2</b>				
S1706	Install Heating, Ventilation and Air Conditioning Systems and Components	30	24	6
S1707	Install Roofing and Architectural Metal	30	15	15
S1708	Lay-out and Drafting 2	87	54	33
S1709	Interpret and Design Systems 1	69	69	0
S1710	Weld and Cut 2	24	6	18
	<b>Sub-Totals for Level 2</b>	<b>240</b>	<b>168</b>	<b>72</b>
<b>LEVEL 3</b>				
S1711	Test, Adjust and Balance	30	24	6
S1712	Fabricates and Installs Industrial Environmental Systems and Specialized Installations	39	39	0
S1713	Lay-out and Drafting 3	102	57	45
S1714	Interpret and Design Systems 2	45	45	0
S1715	Weld and Cut 3	24	12	12
	<b>Sub-Totals for Level 3</b>	<b>240</b>	<b>177</b>	<b>63</b>
<b>TOTAL</b>		<b>720</b>	<b>507</b>	<b>213</b>

# Sheet Metal Worker

## **Level 1**

SHEET METAL WORKER – LEVEL 1

Number: **S1701**

Reportable Subject: **FABRICATES FOR SHOP AND FIELD**

Duration: Total 54 hours      Theory 42 hours      Practical 12 hours

Prerequisites: None

**Evaluation Structure**

Theory Testing	45%
Practical Exercises	20%
Final Assessment	35%

**S1701.1 Identify and Select Materials in the Trade**

Duration: Total 6 hours Theory 6 hours Practical 0 hours

Cross Reference to Training Standards: 0344.01, 0344.03

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to select materials used in the trade.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 1.1.1 Identify metal characteristics.
- 1.1.2 Select the metals used for the appropriate applications.

**LEARNING CONTENT:**

**1.1.1 Identify metal characteristics:**

- (3/0) Mechanical Properties:
- brittleness
  - ductility
  - malleability
  - toughness
  - tensile strength
  - hardness
  - corrosion
  - ferrous
  - non ferrous
  - annealing

**1.1.2 Select the metals used for the appropriate applications.**

- (3/0) Base Metals:
- hot/cold rolled steel
  - copper
  - aluminums
  - zinc
  - lead
- Coated Metals:
- galvanized
  - P.V.C. coated steel
  - satin coat
  - tin plate
  - anodized aluminium
- Alloys:
- stainless steel
  - aluminium
  - electrolysis
  - galvanized steel
  - stainless steel
  - austenitic
  - martensitic
  - aluminium
  - copper
  - brass

## SHEET METAL WORKER – LEVEL 1

### Material Thickness Gauge:

- material gauging
- micrometer
- United States Standard Gauge
- American Wire Gauge
- Brown-Sharpe
- Birmingham Gauge

### Material Weights:

- pounds
- ounces

**S1701.2 Soft Soldering**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0338.03, 0338.07, 0343.11, 0343.12

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to soft solder metals, using appropriate equipment to pass inspection.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 1.2.1 Identify the equipment and components and required safety needed to perform soft soldering.
- 1.2.2 Demonstrate the process required to perform soft soldering safely.

**LEARNING CONTENT:**

**1.2.1 Identify the equipment and components and required safety needed to perform soft soldering.**

- (1/0)
- observe Occupational Health and Safety Act and workplace safety
  - types of soldering coppers
  - techniques for forging, cleaning and tinning irons

Equipment used to heat soldering coppers:

- ovens
- fire pots
- electric irons
- propane/gas irons

**1.2.2 Demonstrate the process required to perform soft soldering safely.**

- (2/3)
- comply with Occupational Health and Safety Act (OHSA)
  - Workplace Hazardous Materials Information System (WHMIS)
  - related shop safety

Types of solders and application:

- composition of solder
- lead free
- 50/50
- 95/5
- eutectic point

Types of flux and application:

- safety when working with flux
- corrosive
- non corrosive

Methods of Applying solder:

- sweating
- skimming
- stitching
- vertical
- horizontal
- overhead

**S1701.3 Types of Seams, Notches and their Applications**

Duration: Total 12 hours Theory 9 hours Practical 3 hours

Cross Reference to Training Standards: 0343.09, 0344.02, 0344.06, 0348.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to select and apply the appropriate seams and notches to diverse applications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 1.3.1 Identify all seams, material allowance and their application.
- 1.3.2 Determine the proper notching procedure for different seams and applications.

**LEARNING CONTENT:**

**1.3.1 Identify all seams, material allowance and their application.**

- (6/2) Types, allowances, formulas, application for:
- longitudinal and transverse seams and joints
  - Pittsburgh seam
  - button lock seam
  - solder pocket
  - single seam
  - double seam
  - snap lock
  - groove seam (ACME)
  - riveted seam, (solid, pop rivet)
  - clinching

Resistance Welding:

- set-up for amperage, weld time and delay
- tip size, type and pressure
- tip cooling system

**1.3.2 Determine the proper notching procedure for different seams and applications.**

- (3/1) Proper notching for seams used on flat patterns and drop cheek, change cheek fittings (rectangular). Round and flat oval fittings with applied formulas.
- Pittsburgh seam
  - button lock seam
  - groove seam
  - single seam
  - double seam
  - solder pocket seam
  - riveted seam
  - spot welded seam
  - clinching

**S1701.4 Types of Connectors, Notches and their Application**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0344.06, 0348.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to select and apply the appropriate connector and notches to different applications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 1.4.1 Identify all connectors and allowances for their application.
- 1.4.2 Determine the proper notching and application for different connectors.

**LEARNING CONTENT:**

**1.4.1 Identify all connectors and allowances for their application.**

- (2/1.5) Types, Allowances, Formulas, Applications for:
- “S” cleats (flat and standing)
  - drive cleats (flat and standing)
  - T.D.C. and T.D.F.
  - four bolt duct connector (nexus, ductmate)
  - fish lock or hammer lock
  - coupling for round spirals
  - spiral connector (spiral mate, P.D.Q.)

**1.4.2 Determine the proper notching and application for different connectors.**

- (1/1.5) Proper notching for connectors on flat patterns and drop cheek change cheek fittings (rectangular), round, flat and oval
- “S” cleats (flat and standing)
  - drive cleats (flat and standing)
  - T.D.C. and T.D.F.
  - four bolt duct connector (nexus, ductmate)
  - fish lock or hammer lock
  - coupling for round spiral
  - spiral connector (spiral mate, P.D.Q.)

**S1701.5                    Types of Edges, Notches and their Application**

Duration:                    Total 9 hours                    Theory 6 hours                    Practical 3 hours

Cross Reference to Training Standards: 0344.02, 0344.06, 0348.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to select and apply the appropriate edge and notch to different applications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 1.5.1 Identify all edges and material allowance for their application.
- 1.5.2 Determine the proper notching procedure for different edges and their application.

**LEARNING CONTENT:**

**1.5.1 Identify all edges and material allowances for their application.**

- (3/1.5)
- single hem
  - double hem
  - angle hem
  - blind edge
  - capped edge
  - band edge
  - wired edge

**1.5.2 Determine the proper notching procedure for different edges and their application.**

- (3/1.5)
- single hem
  - double hem
  - angle edge
  - blind edge
  - capped edge
  - band edge
  - wire edge

**S1701.6 Rigging and Hoisting**

Duration:      Total 15 hours                      Theory 15 hours                      Practical 0 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0338.04, 0338.05, 0338.06, 0346.01, 0346.02, 0346.03, 0346.04, 0346.05, 0346.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to perform rigging operations that conform to Ontario Health and Safety Act (OHSA), Construction Safety Association of Ontario (CSAO) standards, Hoisting Engineers Act and industry safety procedures.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 1.6.1 Identify and perform rigging and hoisting operations.
- 1.6.2 Use hand signals for hoisting and rigging.
- 1.6.3 Inspect and use rigging and hoisting equipment safely.

**LEARNING CONTENT:**

**1.6.1 Identify and perform rigging and hoisting operations.**

- (6/0)
- rigging terms and definitions
  - the use and purpose of rigging and hoisting tools and devices
  - mobile crane types
  - tower cranes
  - hooks
  - slings
  - wire ropes
  - fibre ropes
  - shackles
  - turn buckles
  - rope falls
  - eye bolts
  - cables

Methods to secure loads for hoisting:

- weight distribution
- location for slings and cables
- calculating weights
- safe working loads for fibre rope and wire rope
- knots
- half hitch
- timber hitch
- reef or square
- bowline on a bight
- clove hitch
- cat's paw

**1.6.2 Use hand signals for hoisting and rigging:**

- (3/0)
- responsibility of signal person
  - identify/interpret hand signals
  - demonstrate the use of international hand signals

**1.6.3 Inspect and use rigging and hoisting equipment safely:**

- (6/0) Inspection of:
- wire rope
  - fibre rope
  - slings
  - hooks
  - rope falls
  - chain falls
  - genie lifts
  - hydraulic and mechanical jacks
- Capacity of hoisting equipment/conditions:
- distance and direction of load
  - environmental conditions
  - suitability of ground surface

**Equipment Required for Unit #1**

- Standard Hand Brake
- Slip Roll Former
- Seaming Stakes (hollow mandrel, blow horn, conductor)
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Seaming Stakes
- Groove Seamer
- Rivet Sets
- Bar Folder
- Rotary Turning Machines (elbow edge, burring, turning)
- Soldering Ovens
- Solder 95/5
- Flux
- Soldering Irons

## SHEET METAL WORKER – LEVEL 1

Number: **S1702**

Reportable Subject: **USE AND MAINTAIN HAND/POWER TOOLS AND SHOP EQUIPMENT**

Duration: Total 36 hours                      Theory 26 hours                      Practical 12 hours

Prerequisites: None

### **Evaluation Structure**

Theory Testing	20%
Practical Exercises	40%
Final Assessment	40%

**S1702.1 Select and Maintain Hand Tools**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0338.01, 0338.03, 0338.06, 0339.01, 0339.03

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to use hand tools effectively to perform sheet metal work in accordance with required tolerances.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 2.1.1 Identify and classify the use of hand tools.
- 2.1.2 Determine safety requirements for each tool to be used.
- 2.1.3 Select hand tools appropriate to complete a given task. Demonstrate control of hand tools by completing a practical project.

**LEARNING CONTENT:**

**2.1.1 Identify and classify the use of hand tools.**

(2/0)

Lay-out Tools:

- dividers, trammel points
- making gauges
- circumference rules, steel rules
- squares
- micrometer, vernour callipers

Cutting Tools:

- aviation snips
- pattern snips/straight
- combination snips (hawk bill, circle snips)
- chisels
- drill bits, hole saws

Forming Tools:

- hand seams
- hand notchers and crimpers
- bench stakes (blowhorn, beakhorn, hollow mandrel)
- solid mandrel, conductor, square stakes, creasing stake

Joining Tools:

- groove seamer
- rivet sets
- pop rivets and riveter
- hammers (setting, riveting, ball peen, planishing)

**2.1.2 Determine safety requirements for each tool to be used.**

(1/0)

Use of hand tools for safe operation

- capacity and limitations of hand tools
- maintenance and sharpening
- hand tool maintained and inspection
- appropriate hand tool sharpening (chisel, drill bits, pattern snips)

**2.1.3 Select hand tools appropriate to complete a given task. Demonstrate control of hand tools by completing a practical project.**

(0/3)

Select and demonstrate control of hand tools to perfect a given task (competence outlined under pattern development).

**S1702.2 Select and Maintain Power Tools**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.06, 0339.02, 0342.15

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to select and maintain power tools effectively to perform sheet metal work in accordance with required tolerances.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 2.2.1 Determine proper safe operation of power tools.
- 2.2.2 Determine appropriate power tools for tasks to be completed.

**LEARNING CONTENT:**

**2.2.1 Determine proper safe operation of power tools.**

- (2/0) Determine power tool capacity and manufacturer's operating safety procedures.
- grinders
  - cut-off saws
  - nibblers
  - uni- shears
  - screwguns
  - hand drills (electric, hammer, battery)
  - duct hammer
  - comply with occupational health and safety act
  - shop safety and instructions

**2.2.3 Determine appropriate power tools for tasks to be completed.**

- (1/3)
- nibblers
  - uni-shears
  - grinding wheels
  - cut-off blades (types of blades, speeds for different materials)

**S1702.3 Set-up, Use and Maintain Bending Equipment**

Duration: Total 9 hours Theory 6 hours Practical 3 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.05, 0338.06, 0342.01, 0342.03

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to set-up and operate bending equipment within limitations and capacities to produce products to required tolerances from drawing and specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 2.3.1 Identify all bending equipment, set-up, safe operating procedures and capacity.
- 2.3.2 Demonstrate the ability to operate bending equipment safely and according to manufacturer's limitations.

**LEARNING CONTENT:**

**2.3.1 Identify all bending equipment, set-up, safe operating procedures and capacity.**

- (6/0) Manual bending equipment  
Standard hand brake:
- capacity
  - attachments and leaves
  - material thickness set-up
  - reverse bends
  - bend radius

- Box and pan brake:
- capacity
  - finger adjustment
  - bend radius
  - material thickness

- Bar folder:
- wing adjustment
  - finger adjustment
  - capacity
  - production stops

- Cleat benders:
- capacity
  - limitations

- Power bending equipment:
- types of a press brake
  - parts of a press brake
  - safety features
  - upper/lower disc
  - methods of bending (air, coining)

**2.3.2 Demonstrate the ability to operate bending equipment safely and according to manufacturer's limitations.**

- (0/3) The demonstration and set-up of bending equipment is incorporated with projects to be completed. Times are approximations based on projects assigned. These projects are outlined in more detail in the pattern development unit.

**S1702.4 Set-up, Use and Maintain Forming and Cutting Equipment**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0338.01, 0338.05, 0342.04, 0342.06, 0342.07, 0342.09

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to set-up and operate manual forming and cutting equipment within limitations and capacities to required tolerances from drawing and specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 2.4.1 Identify forming equipment, set-up procedures and capacity.
- 2.4.2 Demonstrate the ability to operate forming equipment safely and according to manufacturer's limitations.
- 2.4.3 Identify cutting equipment, set-up procedures and capacity.
- 2.4.4 Demonstrate the ability to operate cutting equipment safely and according to manufacturer's limitations.

**LEARNING CONTENT:**

**2.4.1 Identify forming equipment, set-up procedures and capacity.**

- (1.5/0) Pittsburgh:
- gauge limitations
  - minimum material length
- Button Lock:
- gauge limitations
  - minimum material length
- Rotary Turning Machines:
- gauge limitations
  - beading rolls
  - crimping rolls
  - burring rolls
  - turning rolls
  - elbow edge rolls
  - wire rolls
  - slitting rolls
  - offset rolls
  - flanging rolls
  - easy edger
  - single seamer
  - double seamer

**2.4.2 Demonstrate the ability to operate forming equipment safely and according to manufacturer's limitations.**

- (0/1) The demonstration of the use and set-up of forming equipment is integrated with projects to be completed in the practical applications. The time allotted for the practical is only an approximation based on projects assigned. These are outlined in more detail in the pattern development unit. Safety is an ongoing part of this and all sections dealing with the fabrications of components, use of shop equipment and shop practices.

**2.4.3 Identify cutting equipment, set-up procedures and capacity.**

- (1.5/0) Manual and power shears:
- identify components
  - capacity
  - front and back gauge operation
  - bevel gauge, combination gauge operation
  - cutting material in the shear to required specifications
  - interpret manufacturer's specification to determine maintenance and safe operating procedures

Cutting Table: (shop master)

- identify components
- capacity
- interpret manufacturer's specification to determine
- maintenance requirements and safe operating procedures
- set-up of material on cutting table for cutting the width and the length of a sheet
- duct notcher

Drill Press:

- parts and adjustments
- drill speeds
- lubrication

**2.4.4 Demonstrate the ability to operate cutting equipment safely and according to manufacturer's limitations.**

- (0/2) The demonstration of the use and set-up of cutting equipment is integrated with projects to be completed in the practical application. The time allotted for the practical is only an approximation based on projects assigned. These are outlined in more detail in the pattern development unit. Safety is an ongoing part of this and all sections dealing with the fabrication of components, use of shop equipment and shop practices.

**S1702.5 Identify and Describe the use of Specialized Shop Equipment**

Duration: Total 9 hours Theory 9 hours Practical 0 hours

Cross Reference to Training Standards: 0342.07, 0342.10, 0342.11, 0342.12, 0342.14, 0342.16, 0342.17, 0342.18

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to recognize and describe the operation of specialized shop equipment, as well as input information into computer related software.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 2.5.1 Describe the operation of specialized shop equipment.
- 2.5.2 Enter variables to produce shop fitting for fabrication on CAD equipment.

**LEARNING CONTENT:**

**2.5.1 Describe the operation of specialized shop equipment.**

- (1/0)
- ring rolling (iron workers)
  - duct/ coil line
  - spiral and flex forming machines
  - computer plasma/laser cutting tables
  - ring and circle shear

**2.5.2 Enter variables to produce shop fitting for fabrication on CAD equipment.**

- (8/0)
- create shop drawing for fabrication
  - call up appropriate fitting screen and enter dimension
  - store and save files on hard drive and disk.

**GENERAL PRACTICES:**

This topic covers concepts and competencies that are demonstrated and covered in part in other areas and are integrated together.

**Equipment Required for Unit #2**

- Standard Hand Brake
- Slip Roll Former
- Pittsburgh Roll Former
- Button Lock Roll Former
- Bar Folder
- Rotary Turning Machines (elbow edge, burring, turning, wire, easy edger, crimping, beading)
- Cut-off Saw
- Grinder
- Uni-shear
- Drill Press
- Box and Pan Brake
- Press Brake
- Squaring Shear

## SHEET METAL WORKER – LEVEL 1

Number: **S1703**

Reportable Subject: **LAY-OUT AND DRAFTING 1**

Duration: Total 99 hours      Theory 60 hours      Practical 39 hours

Prerequisites: S1701

### **Evaluation Structure**

Theory Testing      50%

Practical Exercises      20%

Final Assessment      30%

**S1703.1 Lay-out and Drafting Equipment and Applied Geometry**

Duration: Total 9 hours Theory 6 hours Practical 3 hours

Cross Reference to Training Standards: 0341.01, 0341.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to select the appropriate lay-out tools and perform required geometry to produce patterns and fittings to required specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 3.1.1 Select and demonstrate the use of appropriate lay-out tools.
- 3.1.2 Apply the geometry required to produce accurate patterns.

**LEARNING CONTENT:**

**3.1.1 Select and demonstrate the use of appropriate lay-out tools.**

- (3/1.5)
- dividers
  - trammel points
  - architectural scales (metric/imperial)
  - mechanical scales (metric/imperial)
  - templates
  - 45 squares
  - 30/60 squares
  - parallel rules
  - demonstrate proper use of lay-out tools
  - complete work assignments to required tolerances

**3.1.2 Apply the geometry required to produce accurate patterns.**

(3/1.5) Identify parts of a circle:

- circumference
- sector
- cord
- segment
- radius
- diameter

Construction of shapes and angles:

- round, oval, rectangular
- irregular, triangles
- developing triangles required by bisecting and related formulas
- language of lines
- construction of lines to varies angles and positions using geometry

**S1703.2 Simple and Straight Line Lay-out**

Duration: Total 21 hours Theory 9 hours Practical 12 hours

Cross Reference to Training Standards: 0341.01, 0341.02, 0341.04, 0341.05, 0341.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut out accurate stretch out patterns to required tolerances.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 3.2.1 Develop patterns using simple and straight line lay-out.
- 3.2.2 Produce accurate patterns using simple and straight line lay-out.

**LEARNING CONTENT:**

**3.2.1 Develop patterns using simple and straight line lay-out.**

- (9/3) Applied terms and definitions:
- net pattern
  - gross pattern
  - identification of lay-out lines used
  - apply forming or information diagrams to work pieces
- Perform required trade calculation:
- belt lengths for elbows
  - ogee offsets net/gross
  - cheek cut sizes net/gross
  - transition cut sizes net/gross

**3.2.2 Produce accurate patterns using simple and straight line lay-out.**

- (0/6) Lay-out and develop appropriate fitting:
- rectangular duct
  - rectangular elbows (square, radius)
  - offsets (straight line, ogee, mitres)
  - transitions
  - rectangular “Y” branches (2 way, 3 way clusters)
- (0/3) Lay-out of pieces to demonstrate ability to apply:
- wire edges
  - solder pocket lock (coffin lock)
  - single seam
  - double seam
  - single and double hem

**S1703.3 Parallel Line Lay-out**

Duration: Total 36 hours Theory 24 hours Practical 12 hours

Cross Reference to Training Standards: 0341.01, 0341.02

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut accurate patterns for fittings, employing the parallel line method to required tolerances.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 3.3.1 Demonstrate the use of parallel line principles.
- 3.3.2. Develop accurate patterns and fittings using parallel line.

**LEARNING CONTENT:**

**3.3.1 Demonstrate the use of parallel line principles.**

- (15/0)
- identify types of fittings that require parallel line
  - discuss methods for developing stretch-outs
  - identify views required and their importance
  - establish a numbering system for clarification and reference points, hidden lines
  - apply appropriate formulas
  - circumference net
  - circumference gross (including applied seams and joints)

**3.3.2 Develop accurate patterns and fittings using parallel line.**

- (15/12)
- Develop (round, oval and irregular shapes) net and gross patterns for:
- elbows, nested and non-nested
  - offsets
  - lateral-on centre
  - offsetting laterals
  - tees-on centre
  - offsetting tees
  - roof jacks-on centre
  - offsetting roof jacks
  - "Y" branch

Fabrications of parallel line fittings:

- elbows
- laterals-offsetting
- roof jack

Apply appropriate seams and joint for fabrication:

- elbow edge
- lap seam
- groove seam
- cup/lap
- solder joint
- standing seam

**S1703.4 Radial Line Lay-out**

Duration: Total 15 hours Theory 9 hours Practical 6 hours

Cross Reference to Training Standards: 0341.01, 0341.03

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings, employing the radial line method to the tolerances required.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 3.4.1 Describe the principles to radial line lay-out.
- 3.4.2 Develop accurate patterns and fittings using radial line lay-out.

**LEARNING CONTENT:**

**3.4.1 Describe the principles to radial line lay-out.**

- (3/0) Define:
- apex vertex
  - frustum of a cone
  - truncated of irregular frustum of a cone
  - right cones
  - true length lines
  - radial lines
  - stretch-out arc
  - views required
  - related formulas

**3.4.2 Develop accurate patterns and fittings using radial line lay-out.**

- (6/6) Develop net and gross patterns for:
- round reducer
  - rain caps and storm collars
  - conical roof jacks

**S1703.5 Triangulation Lay-out**

Duration:      Total 15 hours                      Theory 9 hours                      Practical 6 hours

Cross Reference to Training Standards: 0341.01, 0341.04

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings, employing the triangulation method to the tolerances required.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 3.5.1 Describe the principles to triangulation lay-out.
- 3.5.2 Develop accurate patterns and fittings using triangulation.

**LEARNING CONTENT:**

**3.5.1 Describe the principles to triangular lay-out.**

- (3/0) Principal method of triangulation:
- plan and elevation view
  - take the foreshortened length from the plan and triangulate it against its vertical rise
  - methodology of point transfer onto stretch-out

Related formulas:

- trigonometry as applied to transition to determine cut sizes

**3.5.2 Develop accurate patterns and fittings using triangulation.**

- (9/6) Develop net and gross patterns for:
- rectangular transitions
  - square to round fittings

Fabricate from developed patterns:

- rectangular transitions with applied joints and seams
- square to rounds
- groove seam
- elbow edge
- “s” and drive
- flanged

**Equipment Required for Unit 3**

- Standard Hand Brake
- Slip Roll Former
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Seaming Stakes
- Groove Seamer
- Rivet Sets
- Bar Folder
- Rotary Turning Machines (elbow edge, burring, turning, wire, beading, crimping, easy edger)
- Box and Pan Brake
- Squaring Shear
- Cheek Bender

## SHEET METAL WORKER – LEVEL 1

Number: **S1704**

Reportable Subject: **READ, INTERPRET AND PRODUCE DRAWINGS**

Duration: Total 27 hours      Theory 27 hours      Practical 0 hours

Prerequisites: None

### **Evaluation Structure**

Theory Testing      60%

Practical Exercises      0%

Final Assessment      40%

**S1704.1 Read Drawings and Specifications to Determine Work to be Performed**

Duration: Total 6 hours Theory 6 hours Practical 0 hours

Cross Reference to Training Standards: 0340.01, 0340.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to determine work to be performed by accurately interpreting drawings and specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 4.1.1 Identify the different types of plans and prints used to construct mechanical systems.
- 4.1.2 Demonstrate the ability to comprehend specifications, building and fire codes related to mechanical systems.

**LEARNING CONTENT:**

**4.1.1 Identify the different types of plans and prints used to construct mechanical systems.**

- (3/0) Print sections:
- architectural
  - structural
  - mechanical
  - electrical
  - plan and elevation
  - interferences
  - distinguish between the different lines and symbols used in drawings
  - drawing inter-relation by symbols
  - scales
  - use arch scale ruler to determine job line
  - convert decimals to fractions (reverse)
  - metric to imperial (reverse)

**4.1.2 Demonstrate the ability to comprehend specifications, building and fire codes related to mechanical systems**

- (3/0) Divisions of specification
- Ontario Building Code
  - National Building Code
  - Ontario Fire Code
  - job specifications

**S1704.2 Produce Free-hand Sketches and Drawings to Illustrate to Others  
Work to be Performed**

Duration: Total 21 hours Theory 21 hours Practical 0 hours

Cross Reference to Training Standards: 0340.02, 0340.03, 0340.04, 0341.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to produce free-hand sketches and detailed drawings using drafting equipment, templates and CAD system to illustrate to others, work to be performed.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 4.2.1 Produce shop drawings using drafting equipment and templates for fabrication.
- 4.2.2 Produce drawings using drafting equipment and CAD programs.

**LEARNING CONTENT:**

**4.2.1 Produce shop drawings using drafting equipment and templates for fabrication.**

- (7/0) Determine how to sketch work clearly:
- isometric
  - orthographic
  - perspective

Produce shop fabrication sheet:

- free-hand
- drafting equipment, templates
- dimensioning techniques

Produce take-off from drawings and prints

**4.2.2 Produce drawings using drafting equipment and CAD programs.**

- (14/0) Select appropriate scales based on:
- paper size
  - clarity
  - metric/imperial

Use CAD computer software (e.g. Auto-Cad, Wrightsoft, Vulcan, Quickpen) to produce drawings

**Equipment Required for Unit #4**

- Ontario Building Code
- National Building Code
- Ontario Fire Code
- CAD Software (Auto-Cad, Vulcan, Writesoft, Quickpen)

## SHEET METAL WORKER – LEVEL 1

Number: **S1705**

Reportable Subject: **WELD AND CUT 1**

Duration: Total 24 hours      Theory 9 hours      Practical 15 hours

Prerequisites: None

### **Evaluation Structure**

Theory Testing      20%

Practical Exercises      60%

Final Assessment      20%

**S1705.1 Cut Ferrous Metals Using Oxy-fuel Process and Plasma Cutting Techniques**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0343.01, 0343.02, 0343.03

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to accurately cut ferrous metals using plasma and oxy-fuel process.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 5.1.1 Set-up and safely use plasma and oxy-fuel cutting equipment.
- 5.1.2 Demonstrate the safe use of plasma and oxy-fuel cutting.

**LEARNING CONTENT:**

**5.1.1 Set-up and safely use plasma and oxy-fuel cutting equipment.**

- (3/1.5) Identify the relevant sections of the:
- Canadian Welding Bureau
  - Occupational Health and Safety Act

Safety required in set-up:

- gauges
- tank pressures
- flash arrestors

Proper safety apparel:

- glasses (shading)
- face shields
- gloves
- boots
- jacket/apron

Equipment set-up:

- types of fuel
- tip size
- gas pressures
- flame adjustment
- equipment start-up and shut-down
- proper cutting procedure

**5.1.2 Demonstrate the safe use of plasma and oxy-fuel cutting.**

- (0/1.5) Demonstrate proper set-up and cutting procedure for:
- thin sheet metal
  - thick steel
  - piercing holes
  - chamfering
  - pipe and tube

**S1705.2 Set-up and Operate Shielded Metal Arc Welding Equipment**

Duration: Total 9 hours Theory 3 hours Practical 6 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0343.04

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to weld in all positions to meet codes and standards, using shield metal arc welding (S.M.A.W.).

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 5.2.1 Describe the safe operation and set-up of shielded metal arc welding equipment.
- 5.2.2 Demonstrate the ability to use shielded metal arc welding equipment and techniques.

**LEARNING CONTENT:**

**5.2.1 Describe the safe operation and set-up of shielded metal arc welding equipment.**

- (3/0) Interrupt and comply with:
- Canadian Welding Bureau
  - Occupational Health and Safety Act

Identify and select body protection equipment:

- aprons, jackets
- gloves
- gauntlet sleeves
- helmets and lens shading
- masks

Describe welding symbols for common types of welds:

- butt
- lap
- fillet
- stitch
- weld all around
- field weld

Welding equipment required and proper set-up:

- preparing the material for welding
- cleaning the weld

**5.2.2 Demonstrate the ability to use shielded metal arc welding equipment and techniques.**

- (0/6) Demonstrate the ability to perform welds on light gauge material:
- butt
  - lap
  - corner
  - tee
  - edge joints
  - fillet
  - slot
  - tack
  - flat
  - vertical
  - overhead
  - horizontal

**S1705.3 Set-up and Operate Gas Metal Arc Welding Equipment**

Duration: Total 9 hours Theory 3 hours Practical 6 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0343.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to gas metal arc weld in all positions to meet codes and specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 5.3.1 Describe the safe operation and set-up of Gas Metal Arc Welding equipment.
- 5.3.2 Demonstrate the ability to use Gas Metal Arc Welding equipment and techniques.

**LEARNING CONTENT:**

**5.3.1 Describe the safe operation and set-up of Gas Metal Arc Welding equipment.**

- (3/0)
- Interpret and comply with:
- Canadian Welding Bureau
  - Occupational Health and Safety Act
  - comply with shop safety requirements
- Identify and describe:
- common weld joints
  - filler wire
  - different weld application
  - set-up, adjustments required to perform GMAW on ferrous and non-ferrous materials
  - types of welders and accessories required
  - types of shielding gases and recommended pressures for ferrous and non-ferrous materials

**5.3.2 Demonstrate the ability to use Gas Metal Arc Welding equipment and techniques.**

- (0/6)
- machine set-up and adjustment
  - butt
  - lap
  - corner
  - tee
  - edge joint
  - fillet
  - tack
  - flat position
  - vertical
  - over head
  - horizontal

**Equipment Required for Unit #5**

- Oxy-fuel Cutting Torches and consumables
- Plasma Torch and consumables
- Shielded Metal Arc Welding Machines and consumables
- Gas Metal Arc Welding Machines and consumables

**Equipment Required For Level 1**

- Standard Hand Brake
- Slip Roll Former
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Groove Seamer
- Rivet Sets, Pop Riveters
- Bar Folder
- Oxy-fuel Cutting Torches and consumables
- Plasma Torch
- Shielded Metal Arc Welding Machines and consumables
- Gas Metal Arc Welding Machines and consumables
- Ontario Building Code
- National Building Code
- Ontario Fire Code
- CAD Software
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Rotary Turning Machines (elbow edge, burring, turning, wire, beading, crimping, easy edger)
- Box and Pan Brake
- Squaring Shear
- Cheek Bender
- Cut-off Saw
- Grinder
- Uni-shear
- Drill Press, Hand Drills, Drill Bits
- Press Brake
- Soldering Ovens, Soldering Irons, Flux, Solder

# Sheet Metal Worker

## **Level 2**

SHEET METAL WORKER – LEVEL 2

Number: **S1706**

Reportable Subject: **INSTALL HEATING, VENTILATING AND AIR  
CONDITIONING SYSTEMS AND COMPONENTS**

Duration: Total 30 hours      Theory 24 hours      Practical 6 hours

Prerequisites: S1701, S1702, S1704

**Evaluation Structure:**

Theory Testing	50%
Practical Exercises	10%
Final Assessment	40%

**S1706.1 Installation of Residential and Commercial System Components**

Duration: Total 12 hours Theory 12 hours Practical 0 hours

Cross Reference to Training Standards: 0338.03, 0343.08, 0343.10, 0344.05, 0344.07, 0347.01, 0347.02, 0347.06, 0347.07, 0347.08, 0347.11, 0347.15, 0347.16, 0348.12

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to recommend installation procedures for a complete ducted system, including components, in accordance with manufacturer’s specification and SMACNA standard.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 6.1.1 Interpret manufacturer’s and SMACNA specifications for fabrication and installation of residential and commercial ducted systems.
- 6.1.2 Describe methods of locating and installing residential and commercial air conditioning equipment and their accessories.

**LEARNING CONTENT:**

**6.1.1 Interpret manufacturer's and SMACNA specifications for fabrication and installation of residential and commercial ducted system.**

- (6/0) Describe duct pressures:
- static pressure
  - velocity pressure
  - friction rate
  - total pressure
  - external static pressure
  - equivalent length

Fitting construction standards:

- pressure classification
- gauging of duct/fittings
- joint connection
- intermittent duct reinforcement
- material selection
- ferrous and non-ferrous
- fibreglass reinforced plastic
- rigid fibre glass duct
- hangers and accessories
- elbows
- transitions
- splitter vanes
- offsets
- turning vanes
- "y" branch
- opposed blade dampers
- parallel blade dampers
- butterfly blade dampers
- splitter dampers
- fire dampers

Duct Leakage:

- methods to test for duct leakage
- how to reduce duct leakage
- determine duct leakage

Plastic

- types of plastic used
- methods of lay-out
- welding or bonding principles
- shaping and moulding plastics

**6.1.2 Describe methods of locating and installing residential and commercial air conditioning equipment and their accessories.**

(6/0)

Residential equipment and components:

- interpret manufacturer's specification for medium or high efficiency furnaces
- coil installation procedure
- filter installation procedure
- humidifier installation procedure
- heat recovery ventilators and enthalpy recovery ventilators installation procedure
- types of ducted systems
- demonstrate start-up and evaluation of system

Commercial equipment and components:

- interpret manufacturer's specification for roof top equipment and air handlers
- roof curb installation procedure
- filter installation
- economizer installation
- damper installation procedure
- exhaust and supply fans
- variable air volume boxes

**S1706.2 Industrial System and Components**

Duration: Total 6 hours Theory 6 hours Practical 0 hours

Cross Reference to Training Standards: 0347.01, 0347.03, 0347.04, 0347.05, 0347.12, 0347.13, 0347.17, 0347.18, 0348.01, 0348.02, 0348.03, 0348.04

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to recommend installation procedures for a completed industrial duct system, including components in accordance with SMACNA specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 6.2.1 Interpret manufacturer's and SMACNA specifications for fabrication and installation of industrial ducted systems.
- 6.2.2 Describe the types of material handling systems and installation procedures.

**LEARNING CONTENT:**

**6.2.1 Interpret manufacturer's and SMACNA specifications for fabrication and installation of industrial ducted systems.**

- (3/0) Fitting construction standards:
- pressure classification
  - gauge of duct/fitting
  - joint and seam connection
  - hanger attachment
  - elbows
  - transitions
  - offsets
  - "y" branches
  - stacks and breeching
  - louvers
  - intake and exhaust outlets

**6.2.2 Describe the types of material handling systems and installation procedures.**

- (3/0) Dust collector system:
- reclaim systems
  - air cleaning devices
  - blowers
  - cyclones
  - bag house
  - blast gates
  - conveyor systems
  - fume exhaust hoods
  - industrial ovens and spray booths

**S1706.3 Sound Abatement**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0344.04, 0347.09, 0347.10, 0348.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to distinguish the need for sound abatement and recommend installation techniques according to specifications and SMACNA standards.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 6.3.1 Describe principles of sound abatement.
- 6.3.2 Describe methods to reduce sound attenuation.

**LEARNING CONTENT:**

**6.3.1 Describe principles of sound abatement.**

- (1/0) How sound is reduced:
- distance
  - changing sound waves to heat energy
  - sound intersection loss
  - regenerated noise

**6.3.2 Describe methods to reduce sound attenuation.**

- (2/3) Acoustical insulation:
- adhesive
  - types of pins and clips
  - method of installation
- Vibration elimination devices:
- isolators
  - inertia pads
  - flexible duct connector
  - active and dissipative silencers

**Equipment Required For Unit 6**

- Pin Spotter
- Adhesive
- Insulation Pins and Clips
- Acoustical Insulation

## SHEET METAL WORKER – LEVEL 2

Number: **S1707**

Reportable Subject: **INSTALL ROOFING AND ARCHITECTURAL METAL**

Duration: Total 30 hours      Theory 15 hours      Practical 15 hours

Prerequisites: S1701, S1702, S1703, S1704

### **Evaluation Structure:**

Theory Testing      60%

Practical Exercises      10%

Final Assessment      30%

**S1707.1 Architectural Metal and Roof Drainage System for Residential Applications**

Duration: Total 12 hours Theory 6 hours Practical 6 hours

Cross Reference to Training Standards: 0338.02, 0338.03, 0338.06, 0350.04, 0350.05, 0350.07, 0350.09

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to identify, fabricate and install required flashing, metal roof and drainage systems in accordance to SMACNA standards and specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 7.1.1 Identify the installation and types of flashing and metal roof seams used on residential applications.
- 7.1.2 Demonstrate the fabrication and installation techniques of a residential roof drainage system.

**LEARNING CONTENT:**

**7.1.1 Identify the installation and types of flashing and metal roof seams used on residential applications.**

- (3/0) Roof construction:
- identify and define parts of a roof
  - define codes and specifications for roofing and flashing
  - joints and seam types
  - sealing and against leakage
  - caulking
  - soldering
- Types of flashing used on residential houses:
- base
  - counter
  - step
  - chimney saddle
  - soaker
  - starter strip
  - valley flashing
  - chimney cap
- Related formulas:
- trig
  - slope, run and pitch

**7.1.2 Demonstrate the fabrication and installation techniques of a residential roof drainage system.**

- (3/6) Down-spouts:
- conductor outlets
  - conductor pipe
  - styles
  - advantages and disadvantages
  - conductor elbows
  - A style
  - B style
  - conductor shoe
  - supporting conductor pipe
  - conductor heads
  - splash blocks

## SHEET METAL WORKER – LEVEL 2

### Gutter:

- styles
- advantage and disadvantages
- sizing of gutter
- hanging gutter
- installation to ensure proper water removal
- inside meters
- outside meters

**S1707.2 Architectural Metal and Flashing for Commercial and Industrial Applications**

Duration: Total 12 hours Theory 6 hours Practical 6 hours

Cross Reference to Training Standards: 0350.01, 0350.02, 0350.03, 0350.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to identify, fabricate and install flashing and metal roofs for commercial and industrial building according to SMACNA standards and specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 7.2.1 Identify the types of flashing used on commercial and industrial buildings.
- 7.2.2 Identify the types of metal roofs and demonstrate installation procedures used on commercial and industrial buildings.
- 7.2.3 Demonstrate the fabrication of related components.

**LEARNING CONTENT:**

**7.2.1 Identify the types of flashing used on commercial and industrial buildings.**

- (3/0)      Types of flashing:
- coping
  - scuppers
  - pitch pocket
  - counter
  - base
  - thru-wall
  - parapet wall
  - curbs
  - sleepers
  - expansion joints
  - methods to ensure waterproof seams and joints
  - safe installation practices
  - prevention of galvanic action
  - coefficient of thermal expansion

**7.2.2 Identify the types of metal roofs and demonstrate installation procedures used on commercial and industrial buildings.**

- (3/0)      Metal roofs and decking:
- batten
  - standing
  - lap
  - hook
  - Q deck
  - Z deck
- Installation to ensure:
- proper expansion and contraction
  - required roof pitch
  - ensure waterproof installation

**7.2.3 Demonstrate the fabrication of related components.**

- (0/6)      - corner mitres
- slip joints for expansion and contraction
  - curbs
  - batten seam
  - hook seam

**S1707.3 Roof Accessories**

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Cross Reference to Training Standards: 0348.13, 0348.14

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability recommended installation and fabrication procedures for various roof accessories.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 7.3.1 Recommend installation procedures for roof accessories.
- 7.3.2 Recommend fabrication procedures for roof accessories.
- 7.3.3 Demonstrate fabrication techniques for related roof accessories.

**LEARNING CONTENT:**

**7.3.1 Recommend installation procedures for roof accessories.**

- (2/0)
- skylights
  - roof entries
  - louvered enclosures
  - roof curbs and curb adaptors
  - cupolas

Describe waterproofing techniques:

- soldering
- sealing
- seams
- locks
- fasteners

**7.3.2 Recommend fabrication procedures for roof accessories.**

- (1/0)
- ventilators
  - free area
  - minimum distance off roof
  - curbs
  - curb adaptor
  - cupolas

**7.3.3 Demonstrate fabrication techniques for related roof accessories.**

- (0/3)
- louvers
  - ventilators

**Equipment Required For Unit 7**

- Standard Hand Brake
- Slip Roll Former
- Spot Welder
- Bar Folder
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Box and Pan Brake
- Squaring Shear
- Drill Press, Hand Drills, Drill Bits
- Soldering Ovens, Soldering Irons, Flux, Solder

## SHEET METAL WORKER – LEVEL 2

Number: **S1708**

Reportable Subject: **LAY-OUT AND DRAFTING 2**

Duration: Total 87 hours      Theory 54 hours      Practical 33 hours

Prerequisites: S1701, S1703

### **Evaluation Structure:**

Theory Testing      40%

Practical Exercises      40%

Final Assessment      20%

**S1708.01 PARALLEL LINE LAY-OUT**

Duration: Total 15 hours Theory 9 hours Practical 6 hours

Cross Reference to Training Standards: 0341.01, 0341.02, 0341.05, 0341.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings employing parallel line lay-out.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 8.1.1 Develop patterns using parallel line lay-out techniques.
- 8.1.2 Cut and assemble patterns using parallel line lay-out techniques.

**LEARNING CONTENT:**

**8.1.1 Develop patterns using parallel line lay-out techniques.**

- (9/0)          Develop patterns:
- lay-out requiring multiple views
  - hidden lines
  - multiple intersections

Identify proper symbols for:

- brake points
- notches
- seams
- areas to be rolled or formed

**8.1.2 Cut and assemble patterns using parallel line lay-out techniques.**

- (0/6)          Fabricate fittings for:
- multiple gored fittings
  - “Y” branches
  - shoe boot fittings

**S1708.2 Radial Line Lay-out**

Duration: Total 36 hours Theory 21 hours Practical 15 hours

Cross Reference to Training Standards: 0341.01, 0341.03, 0341.05, 0341.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings employing radial line lay-out.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 8.2.1 Develop patterns using radial line lay-out techniques.
- 8.2.2 Cut and assemble patterns using radial line lay-out techniques.

**LEARNING CONTENT:**

**8.2.1 Develop patterns using radial line lay-out techniques.**

- (21/0)      Develop patterns:
- lay-out requiring multiple views
  - hidden lines
  - multiple intersections
- Identify proper symbols for:
- brake points
  - notches
  - seams
  - areas to be rolled or formed

**8.2.2 Cut and assemble patterns using radial line lay-out techniques.**

- (0/15)      Fabricate fittings for:
- round reducers
  - oblique reducers
  - conical laterals
  - offset conical laterals
  - conical tees
  - offset conical tees
  - “Y” branch
  - tapering elbows
  - conical branch on conical body

**S1708.3      Triangulation Lay-out**

Duration:      Total 42 hours      Theory 24 hours      Practical 18 hours

Cross Reference to Training Standards: 0341.01, 0341.04

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings employing the triangulation method.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 8.3.1 Demonstrate the use of triangulation principles.
- 8.3.2 Develop, cut and assemble round and oval fittings using the principle method of triangulation.

**LEARNING CONTENT:**

**8.3.1 Demonstrate the use of triangulation principles.**

- (12/6) Lay-out, calculate and fabricate:
- drop cheek change cheek elbows
  - drop cheek ogee offset
  - 2 way and 3 way “Y” branches
  - transitions
  - apply related formulas
  - develop patterns using related computer software (CAD, Vulcan)

**8.3.2 Develop, cut and assemble round and oval fittings using the principle method of triangulation.**

- (12/12) Principal Method:
- plan view
  - vertical height
  - transference of points
  - method of checking for accuracy

- Develop Patterns for:
- round/round reducer
  - round/oval reducer
  - square/round fittings

- Fabricate fittings for:
- round/round reducer
  - square/round fittings

**Equipment Required For Unit 8**

- Standard Hand Brake
- Slip Roll Former
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Groove Seamer
- Rivet Sets, Pop Riveters
- Bar Folder
- CAD Software (Vulcan, Quickpen, Auto-Cad)
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Rotary Turning Machines (elbow edge, burring, turning, wire, beading, crimping, easy edger)
- Box and Pan Brake
- Squaring Shear
- Cheek Bender
- Uni-shear
- Drill Press, Hand Drills, Drill Bits
- Soldering Ovens, Soldering Irons, Flux, Solder

SHEET METAL WORKER – LEVEL 2

Number: **S1709**

Reportable Subject: **INTERPRET AND DESIGN SYSTEMS 1**

Duration: Total 69 hours      Theory 69 hours      Practical 0 hours

Prerequisites: S1704

**Evaluation Structure:**

Theory Testing	60%
Practical Exercises	0%
Final Assessment	40%

**S1709.1 Residential Load Estimating**

Duration: Total 33 hours Theory 33 hours Practical 0 hours

Cross Reference to Training Standards: 0340.01, 0340.03, 0340.04, 0340.05, 0340.06, 0340.07

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to calculate and design a complete heating ventilation and cooling system for a residential application.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 9.1.1 Determine calculations and information required to produce a load estimate on a residential application.
- 9.1.2 Determine the ability to produce a load estimate on a residential application using appropriate computer software (e.g Wrightsoft, Carrier).

**LEARNING CONTENT:**

**9.1.1 Determine calculations and information required to produce a load estimate on a residential application.**

(17/0) Interpret and apply to residential application:

- Ontario Building Code
- National Building Code
- SMACNA
- ASHRAE

Load estimations:

- heat transfers
- term and definitions
- design temperatures
- “U” factors
- “R” factors
- cooling factors
- ventilation loads
- related formulas
- complete loads

**9.1.2 Determine the ability to produce a load estimate on a residential application using appropriate computer software (e.g. Wrightsoft, Carrier).**

(16/0) Produce load estimate on related computer software (e.g. Wrightsoft, Carrier):

- heating
- cooling
- ventilation
- apply related formulas
- select equipment from final load
- types of air handlers
- efficiencies
- related codes for clearance

**S1709.2 Residential Duct Design**

Duration: Total 24 hours Theory 24 hours Practical 0 hours

Cross Reference to Training Standards: 0340.02, 0340.03, 0340.05, 0340.07

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to calculate and produce a duct design for a residential application.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 9.2.1 Define terminology applied to duct sizing.
- 9.2.2 Develop a duct system using equal friction method.

**LEARNING CONTENT:**

**9.2.1 Define terminology applied to duct sizing.**

- (12/0) Define:
- velocity pressure
  - static pressure
  - total pressure
  - C.F.M.
  - F.P.M.
  - friction rate
  - equivalent length
  - effective length
  - external static pressure
  - total system resistance
  - equal friction

**9.2.2 Develop a duct system using equal friction method.**

- (12/0) Related formulas:
- convert velocity pressure to velocity
  - calculate fitting loss
  - calculate cubic feet/min
  - calculate velocity
  - calculate area
  - ratio and proportion
  - calculate external static pressure
- Design a system:
- using ductulator
  - computer software (e.g. Wrightsoft, Carrier)
  - determine number of outlets
  - assign air quantities
  - size duct
  - calculate total system resistance
  - select equipment
- Produce a complete drawing:
- determine appropriate scale to use
  - determine route for duct
  - determine location of supply and return
  - determine aspect ratio and shape of ducted system
  - draw duct to scale using related symbols

**S1709.3 Residential Cost Estimating**

Duration: Total 12 hours Theory 12 hours Practical 0 hours

Cross Reference to Training Standards: 0340.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to complete a cost estimate for a given job.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 9.3.1 Determine calculations and components required to produce a cost estimate, manually or using computer software.
- 9.3.2 Produce a final cost estimate for a residential application.

**LEARNING CONTENT:**

**9.3.1 Determine calculations and components required to produce a cost estimate, manually or using computer software.**

- (6/0)
- determine a procedure to produce a cost estimate
  - establish method of cost estimate
  - price per pound
  - price per component

Related formulas:

- area, volume
- metric and imperial calculations
- establish equipment and accessories cost
- complete shop list for fitting fabrication, manually and using
- related CAD software (e.g. Vulcan, Wrightsoft)

**9.3.2 Produce a final cost estimate for a residential application.**

- (6/0)
- Final cost estimate manually and with computer software:
- labour cost for fabrication and installation
  - metal costs
  - metal utilization and fitting cost
  - equipment cost
  - installation components, include mark-up, overhead and profit

**Equipment Required For Unit 9**

- Ontario Building Code
- CAD Software (Vulcan, Quickpen, Auto-Cad)
- Heat Loss and Gain Software (Writesoft, Carrier)

SHEET METAL WORKER – LEVEL 2

Number: **S1710**

Reportable Subject: **WELD AND CUT 2**

Duration: Total 24 hours      Theory 6 hours      Practical 18 hours

Prerequisites: S1701, S1705

**Evaluation Structure:**

Theory Testing	20%
Practical Exercises	60%
Final Assessment	20%

**S1710.1 Set-up and Operate Gas Metal Arc Welding Equipment**

Duration: Total 12 hours Theory 3 hours Practical 9 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0338.06, 0338.07, 0343.05, 0343.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to Gas Metal Arc Weld, adhering to codes and standards as specified.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

10.1.1 Describe the safe set-up and operation for Gas Metal Arc Welding (GMAW).

10.1.2 Demonstrate the ability to set-up and operate Gas Metal Arc Welding equipment for ferrous and non-ferrous materials.

**LEARNING CONTENT:**

**10.1.1 Describe the safe set-up and operation for Gas Metal Arc Welding (GMAW).**

- (3/0) Interpret and comply with:
- Occupational Health and Safety Act
  - Canadian Welding Bureau
- Review:
- welding symbols
  - welding specifications
  - equipment set-up for ferrous and non-ferrous
  - safety

**10.1.2 Demonstrate the ability to set-up and operate Gas Metal Arc Welding equipment for ferrous and non-ferrous materials.**

- (0/9) Demonstrate the ability to perform GMAW on:
- lateral branches
  - gore seam
  - longitudinal seams
  - ferrous and non-ferrous
  - mild steel
  - stainless steel
  - aluminium

**S1710.2 Set-up and Operate Gas Tungsten Arc Welding Equipment**

Duration: Total 12 hours Theory 3 hours Practical 9 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0338.06, 0343.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to Gas Tungsten Arc Weld (GTAW), adhering to codes and standards as specified.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 10.2.1 Describe the safe set-up and operation for Gas Tungsten Arc Welding.
- 10.2.2 Demonstrate the ability to set-up and operate Gas Tungsten Arc Welding equipment for ferrous and non-ferrous metals.

**LEARNING CONTENT:**

**10.2.1 Describe the safe set-up and operation for Gas Tungsten Arc Welding.**

- (3/0) Interpret and comply with:
- Occupational Health and Safety Act
  - Canadian Welding Bureau
  - engineering specifications and welding systems

Welding equipment:

- different applications
- filler rod
- tungsten rod
- gases required
- gas pressure
- tig torch

Weld preparation:

- prepare material
- set-up equipment
- fit-up material
- clean weld area before and after

**10.2.2 Demonstrate the ability to set-up and operate Gas Tungsten Arc Welding equipment for ferrous and non-ferrous metals.**

- (0/9) Demonstrate on mild steel:
- butt
  - lap
  - corner
  - tee
  - edge joint
  - fillet
  - tack
  - flat position
  - vertical

Equipment set-up:

- start-up and shut down procedure
- heat settings
- tig torch set-up

**Equipment Required For Unit 10**

- Gas Tungsten Arc Welding Machines and consumables
- Gas Metal Arc Welding Machines and consumables

**Summary of Equipment Required For Level 2**

- Standard Hand Brake
- Slip Roll Former
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Groove Seamer
- Rivet Sets, Pop Riveters
- Bar Folder
- Gas Tungsten Arc Welding Machines and consumables
- Gas Metal Arc Welding Machines and consumables
- Ontario Building Code
- CAD Software (Vulcan, Quickpen, Auto-Cad)
- Heat Loss and Gain Software (Writesoft, Carrier)
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Rotary Turning Machines (elbow edge, burring, turning, wire, beading, crimping, easy edger)
- Box and Pan Brake
- Squaring Shear
- Cheek Bender
- Cut-off Saw
- Grinder
- Uni-shear
- Drill Press, Hand Drills, Drill Bits
- Press Brake
- Soldering Ovens, Soldering Irons, Flux, Solder,
- Insulation, Adhesives, Pins, Clips and Pin-spotter

# Sheet Metal Worker

## **Level 3**

SHEET METAL WORKER – LEVEL 3

Number: **S1711**

Reportable Subject: **TEST, ADJUST AND BALANCE**

Duration: Total 30 hours      Theory 24 hours      Practical 6 hours

Prerequisites: S1701, S1706, S1709

**Evaluation Structure:**

Theory Testing      60%

Practical Exercises      0%

Final Assessment      40%

**S1711.1 Properties of Air**

Duration: Total 9 hours Theory 9 hours Practical 0 hours

Cross Reference to Training Standards: 0349.09, 0349.10, 0349.11

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to define the properties of air and their relationship to moisture for human comfort.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 11.1.1 Define the psychometric properties and their relationship to each other.
- 11.1.2 Determine the condition and properties of air from a psychrometric chart.
- 11.1.3 Determine operating capacity, humidification, dehumidification, heating, cooling and ventilation requirements.

**LEARNING CONTENT:**

**11.1.1 Define the psychrometric properties and their relationship to each other.**

- (3/0) Define the air properties:
- specific volume
  - specific density
  - sensible heat
  - latent heat
  - specific heat
  - enthalpy
  - specific humidity
  - relative humidity
  - air law #1 Daltons Law
  - air law #2 Charles & Boyles
  - wet bulb
  - dry bulb

**11.1.2 Determine the condition and properties of air from a psychrometric chart.**

- (3/0) Identify properties of air on a psychrometric chart:
- using a sling psychrometer
  - plotting 2 known points to find related properties
  - process line
  - evaluating information found on a psychrometric chart
  - sensible and latent heat percentage

**11.1.3 Determine operating capacity, humidification, dehumidification, heating, cooling and ventilation requirements.**

- (3/0) Apply related formulas to determine:
- operating capacity
  - humidification and dehumidification
  - ventilation requirements
  - cooling capacity
  - bypass factor
  - system efficiency
  - apparatus dew point
  - thermal bridging

**S1711.2 Air Moving Devices**

Duration: Total 9 hours Theory 9 hours Practical 0 hours

Cross Reference to Training Standards: 0349.05, 0349.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to recommend installation and testing techniques required for air moving devices.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

11.2.1 Describe the types of air moving devices and their application.

11.2.2 Perform calculations to evaluate fan performance.

**LEARNING CONTENT:**

**11.2.1 Describe the types of air moving devices and their application.**

(3/0) Centrifugal fans and their components:

- forward curve
- backward curve
- radial tip

Axial flow fans and their components:

- propeller
- tube axial
- vane axial
- tubular centrifugal

Describe the applications of centrifugal and axial flow fans.

**11.2.2 Perform calculations to evaluate fan performance.**

(6/0) Apply manufacturer's fan charts:

- describe how fan curves are developed
- how to plot points on a fan curve to determine fan performance

Apply fan laws:

- fan law #1: cubic feet per minute and R.P.M varies directly
- fan law #2: static pressure varies with the square of the increase
- fan law #3: horse power varies with the cube of the increase

Demonstrate the ability to apply fan laws.

**S1711.3 Measure, Record and Adjust**

Duration: Total 12 hours Theory 6 hours Practical 6 hours

Cross Reference to Training Standards: 0349.01, 0349.02, 0349.03, 0349.04, 0349.07, 0349.08, 0349.11

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to measure, record and adjust to produce a balanced system.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 11.3.1 Demonstrate the ability to take readings using various air measuring instruments.
- 11.3.2 Demonstrate the ability to record the readings and determine adjustments required.
- 11.3.3 Demonstrate the ability to make final adjustments from calculations made.

**LEARNING CONTENT:**

**11.3.1 Demonstrate the ability to take readings using various air measuring instruments.**

- (2/3) Evaluate system conditions of equipment and components before taking readings:
- damper position
  - fire dampers
  - register and diffuser
  - filter and coil
  - fan evaluation

Explain the proper and safe use of:

- anemometers
- tachometer
- pitot tubes
- manometers
- tachometers
- flow hoods

Related formulas:

- convert metric/imperial
- convert velocity pressure to feet per minute
- area, volume

**11.3.2 Demonstrate the ability to record the readings and determine adjustments required.**

- (2/1.5) Produce a balance report on the system operation:
- produce schematic of system
  - produce fan performance report
  - evaluate balance report
  - recommend changes to meet system requirements

**11.3.3 Demonstrate the ability to make final adjustments from calculations made.**

- (2/1.5) Calculate changes to be made from balance report:
- safely make fan adjustments
  - make damper adjustments
  - recheck system

**Equipment Required For Unit 11**

- Sling Psychrometer
- Incline Manometer
- Magnahelic Gauge

SHEET METAL WORKER – LEVEL 3

Number: **S1712**

Reportable Subject: **FABRICATES AND INSTALLS INDUSTRIAL ENVIRONMENTAL SYSTEMS AND SPECIALIZED INSTALLATIONS**

Duration: Total 39 hours      Theory 39 hours      Practical 0 hours

Prerequisites: S1704, S1709

**Evaluation Structure:**

Theory Testing	60%
Practical Exercises	0%
Final Assessment	40%

**S1712.1 Fabrication and Installation of Industrial Components**

Duration: Total 12 hours Theory 12 hours Practical 0 hours

Cross Reference to Training Standards: 0348.03, 0348.04, 0348.08, 0348.10

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to describe techniques for installation and fabrication of industrial components according to SMACNA standards and job specifications.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 12.1.1 Describe techniques for fabrication and installation of exhaust hoods and roof ventilators according to SMACNA standards and job specifications.
- 12.1.2 Describe techniques for fabrication and installation of industrial ovens, spray booths and plenums.
- 12.1.3 Describe techniques for fabrication and installation of stainless steel equipment for hospitals, kitchens and general industrial and commercial purposes.

**LEARNING CONTENT:**

**12.1.1 Describe techniques for fabrication and installation of exhaust hoods and roof ventilators according to SMACNA standards and job specifications.**

- (3/0)
- identify duct system design
  - identify fitting standards according to SMACNA
  - identify application filters
  - identify installation procedures for hanging equipment
  - duct/fittings
  - components (hoods)
  - supplementary steel support structure

**12.1.2 Describe techniques for fabrication and installation of industrial ovens, spray booths and plenums.**

- (3/0)
- SMACNA standards for installation of:
- industrial ovens
  - spray booths
  - plenums
  - supplementary steel support structures

Describe self-manufacturing procedures for:

- industrial ovens
- spray booths
- plenums

**12.1.3 Describe techniques for fabrication and installation of stainless steel equipment for hospitals, kitchens and general industrial and commercial purposes.**

- (6/0)
- Describe the practice for custom fabrication of:
- kitchen hoods
  - filter installation
  - tanks
  - exhaust components according to SMACNA specifications

**S1712.2 Industrial Material Handling System Design**

Duration: Total 15 hours Theory 15 hours Practical 0 hours

Cross Reference to Training Standards: 0340.01, 0340.03, 0340.04, 0340.07, 0348.15

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to design an industrial material handling system using Velocity Reduction.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 12.2.1 Describe the requirements to produce a system design for a material handling system using velocity reduction.
- 12.2.2 Produce a complete drawing of a material handling system.

**LEARNING CONTENT:**

**12.2.1 Describe the requirements to produce a system design for a material handling system using velocity reduction.**

- (9/0) Evaluate system requirements:
- material being handled
  - number of stations to be exhausted
  - velocity per station

Hood design:

- cubic feet per minute required
- velocity required
- capture velocity
- particulate suspension
- hood perimeter
- height of hood
- size of duct off hood
- required discharge velocity

Related formulas

Demonstrate how to size duct using Velocity Reduction.

**12.2.2 Produce a complete drawing of a material handling system.**

- (6/0)
- select scale to be used
  - produce double line drawing of duct and components with size indicated on the drawing
  - detailed drawing of hoods

**S1712.3 Air Outlets**

Duration: Total 12 hours Theory 12 hours Practical 0 hours

Cross Reference to Training Standards: 0347.14, 0349.08, 0349.09

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to recommend installation procedures for grills, registers, diffusers and troughers to provide efficient air distribution according to SMACNA and manufacturer's requirements.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 12.3.1 Describe the terminology and techniques required to have an effective air distribution system.
- 12.3.2 Describe the devices and installation practices required to provide effective air distribution.

**LEARNING CONTENT:**

**12.3.1 Describe the terminology and techniques required to have an effective air distribution system.**

- (6/0) Define:
- throw
  - spread
  - drop and rise
  - occupied zone
  - stagnant air
  - A.K. factor
  - isothermal air
  - register
  - grill
  - diffuser
  - troughers

Outlet placement and its effect on air distribution

- high wall
- low wall
- floor
- ceiling

**12.3.2 Describe the devices and installation practices required to provide effective air distribution.**

- (6/0 )
- air straighter
  - air vectrol
  - splitter of branch fittings
  - length of drop for diffusers
  - calculate register size based on A.K. factors
  - calculate outlet placement based on throw
  - placement of outlet in the occupied zone
  - outlet performance from manufacturer's data

**Equipment Required For Unit 12**

- No shop equipment required.

## SHEET METAL WORKER – LEVEL 3

Number: **S1713**

Reportable Subject: **LAY-OUT AND DRAFTING 3**

Duration: Total 102 hours    Theory 57 hours    Practical 45 hours

Prerequisites: S1703, S1708

### **Evaluation Structure:**

Theory Testing    40%

Practical Exercises    20%

Final Assessment    40%

**S1713.1 Triangulation Layout (Rectangular)**

Duration: Total 39 hours Theory 24 hours Practical 15 hours

Cross Reference to Training Standards:

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for rectangular fittings requiring triangulation to tolerance.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 13.1.1 Identify rectangular fittings that require triangulation.
- 13.1.2 Demonstrate methods for accurate pattern development.
- 13.1.3 Produce rectangular fittings accurately employing triangulation and related computer software.

**LEARNING CONTENT:**

**13.1.1 Identify rectangular fittings that require triangulation.**

- (12/0)
- drop cheek elbows
  - drop cheek change check elbows
  - drop cheek “Y” branch
  - transitions with multiple offsets

Notching to allow for:

- “S” and drive connection
- 4 bolt duct connector
- fish lock
- standing “T” drive

**13.1.2 Demonstrate methods for accurate pattern development.**

- (12/0)
- Demonstrate methods to find true lengths:
- related formulas
  - separate true length views
  - short cuts to develop accurate patterns
  - short cut limitations
  - apply seam and joint allowance
  - apply proper notching for related joints and seams

**13.1.3 Produce rectangular fittings accurately employing triangulation and related computer software.**

- (0/15)
- drop cheek elbows
  - drop cheek change check elbows
  - drop cheek ogee offsets
  - drop cheek change check offsets
  - drop cheek “Y” branch fittings
  - 3 way branch fittings
  - transitions
  - related computer software (CAD, Vulcan)
  - apply related trade calculations to determine cut sizes for gross and net patterns

**S1713.2 Triangulation Lay-out (Principle Method)**

Duration: Total 36 hours Theory 21 hours Practical 15 hours

Cross Reference to Training Standards: 0341.04, 0341.05, 0341.06

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings employing the principal method of triangulation to tolerances required.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 13.2.1 Identify the fittings that require the principle method of lay-out.
- 13.2.2 Demonstrate requirements to develop an accurate pattern.
- 13.2.3 Produce fittings accurately using the principle method and related computer software.

**LEARNING CONTENT:**

**13.2.1 Identify the fittings that require the principal method of lay-out.**

- (9/0) Multiple offsets for:
- square to round
  - round to round
  - round to oval
  - oval to square

**13.2.2 Demonstrate requirements to develop an accurate pattern.**

- (12/0) Required views:
- plan view
  - elevation view
  - ways to identify points in all view

Methods to establish proper stretch-out lengths:

- related formulas
- geometry
- line of chord
- checking a pattern for accuracy

Apply seams and joint allowance:

- elbow edge
- standing seam
- groove seam
- lap seam

**13.2.3 Produce fittings accurately using the principle method and related computer software.**

(0/15)

Fittings with consistent elevation:

- square to round
- oval to round
- round to round
- “Y” branches round to oval

Fittings with inconsistent elevation:

- square to round
- oval to round
- round to round
- “Y” branches round to oval
- show numbering sequence
- produce inside patterns
- show forming information diagrams required to produce the fitting
- related software (CAD, Vulcan)

**S1713.3      Triangulation Lay-out (Simplified)**

Duration:      Total 27 hours      Theory 12 hours      Practical 15 hours

Cross Reference to Training Standards: 0341.04, 0341.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to develop and cut patterns accurately for fittings employing short cuts to triangulation to tolerances required.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

13.3.1 Demonstrate short-cut method of lay-out.

13.3.2 Produce fittings accurately using short cuts.

**LEARNING CONTENT:**

**13.3.1 Demonstrate short-cut method of lay-out.**

- (12/0)
- limitations to short cuts
  - check a pattern for accuracy
  - views required

Demonstrate methods to produce patterns for:

- square to round
- round to round
- oval to round
- oval to round “Y” branches
- tapering elbows

**13.3.2 Produce fittings accurately using short cuts.**

- (0/15)
- fittings with consistent elevation
  - fittings with inconsistent elevation
  - fittings with intersections
  - show numbering system
  - show forming diagram to produce a fitting

Produce fittings:

- tapering elbows
- “Y” branch
- lateral and tees
- 3 piece tapering round and oval offsets

**Equipment Required for Unit 13**

- Standard Hand Brake
- Slip Roll Former
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Seaming Stakes
- Groove Seamer
- Rivet Sets
- Bar Folder
- Rotary Turning Machines (elbow edge, burring, turning, wire, beading, crimping, easy edger)
- Box and Pan Brake
- Squaring Shear
- Cheek Bender

SHEET METAL WORKER – LEVEL 3

Number: **S1714**

Reportable Subject: **INTERPRET AND DESIGN SYSTEMS 2**

Duration: Total 45 hours      Theory 45 hours      Practical 0 hours

Prerequisites: S1704, S1709

**Evaluation Structure:**

Theory Testing      70%

Practical Exercises      0%

Final Assessment      30%

**S1714.1 Commercial and Industrial Load Estimating**

Duration: Total 24 hours Theory 24 hours Practical 0 hours

Cross Reference to Training Standards: 0340.05, 0340.07

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to produce a load estimate on a commercial and industrial building using related computer software or manually.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

14.1.1 Describe the requirements to produce a load estimate.

14.1.2 Determine additional load requirements.

14.1.3 Produce a commercial load calculation manually or with computer software.

**LEARNING CONTENT:**

**14.1.1 Describe the requirements to produce a load estimate.**

- (4/0) Interpret/define:
- Ontario Building Code (part 6 and 9)
  - National Building Code
  - ASHRAE manuals
  - H.R.A.I. manuals
  - conduction
  - evaporation
  - convection
  - radiation
  - “U” values
  - design temperatures
  - passive solar gains
  - environmental effects

Related formulas

**14.1.2 Determine additional load requirements.**

- (8/0) Ventilation:
- economizer set-up
  - make-up air
  - related formulas
- Exhaust:
- effects on internal loads
  - compensation for exhaust air
- Internal Environmental effects:
- people and animals
  - manufacturing process
  - commercial process
  - electrical loads
  - humidification and dehumidification
  - related formulas

**14.1.3 Produce a commercial load calculation manually or with computer software.**

(12/0) Produce survey sheet from print and specifications including:

- compass direction of building
- building wall and roof construction
- window construction (number and size)
- doors
- geographical location
- indoor design requirements
- outdoor design temperatures
- ventilation requirements
- internal loads
- external loads

Input information into related computer software to produce a load estimate for evaluation and discussion (e.g. Wrightsoft, Carrier and H.R.A.I.).

**S1714.2 Commercial Duct Design**

Duration: Total 12 hours Theory 12 hours Practical 0 hours

Cross Reference to Training Standards: 0340.07, 0347.07, 0347.14

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to design a commercial duct system using the equal friction method, manually or with computer software.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

- 14.2.1 Describe steps required for a commercial duct lay-out.
- 14.2.2 Describe the equal friction method of duct sizing.
- 14.2.3 Produce a complete drawing of a commercial ducted system manually or with related computer software.

**LEARNING CONTENT:**

**14.2.1 Describe steps required for commercial duct lay-out.**

- (4/0) Describe the system best suited for the application:
- single duct
  - dual duct
  - multi-zone
  - variable air volume or variable air volume-variable temperature
  - terminal reheat
  - zone building
  - locate supply and return
  - sketch single line schematic of duct lay-out
  - size outlets
  - size duct
  - calculate total system resistance
  - select equipment

**14.2.2 Describe the equal friction method of duct sizing.**

- (4/0) Describe:
- velocity pressure
  - static pressure
  - total pressure
  - friction rate
  - describe relationship to duct pressure
  - how to use charts and ductulators to determine duct sizing from cubic feet per minute and velocity
- Demonstrate methods to determine:
- discharge velocity
  - discharge cubic feet per minute
  - friction rate
  - fitting loss
  - duct size
  - total system resistance
  - equipment required

**14.2.3 Produce a complete drawing of a commercial ducted system manually or with related computer software.**

- (4/0)
- select appropriate scale required
  - locate equipment
  - select aspect ratio for application
  - show outlet placement and appropriate duct connections
  - indicate all duct sizes on drawing with related duct symbols with required views
  - show orthographic view of unit and duct

**S1714.3 Commercial and Industrial Cost Estimating**

Duration: Total 9 hours Theory 9 hours Practical 0 hours

Cross Reference to Training Standards: 0340.06, 0347.03, 0347.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to complete a cost estimate for a commercial and industrial job, manually or with related computer software.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

14.3.1 Produce a complete cost estimate for a commercial job.

14.3.2 Produce a complete cost estimate for an industrial job.

**LEARNING CONTENT:**

**14.3.1 Produce a complete cost estimate for a commercial job.**

- (6/0) Produce a list of system components:
- air handling equipment
  - duct fittings and accessories
  - produce shop drawing for duct fittings and accessories
  - analyze labour costs for fabrication and installation using related trade calculations
- Analyze additional cost based on:
- job accessibility
  - location
- Installation requirements according to specifications:
- equipment required
  - mark-up
  - overhead
  - profit

**14.3.2 Produce a complete cost estimate for an industrial job.**

- (3/0) Produce a cost estimate to manufacture industrial components:
- hoods
  - louvers
  - air intake hoods
  - related fittings
  - determine utilization and scrap factor using related formulas

**Equipment Required For Unit 14**

- CAD Software (Vulcan, Quickpen, Auto-Cad)
- Heat Loss and Gain Software (Carrier, Writesoft, H.R.A.I.)

## SHEET METAL WORKER – LEVEL 3

Number: **S1715**

Reportable Subject: **WELD AND CUT 3**

Duration: Total 24 hours      Theory 12 hours      Practical 12 hours

Prerequisites: S1710

### **Evaluation Structure:**

Theory Testing      20%

Practical Exercises      60%

Final Assessment      20%

**S1715.1 Gas Metal Arc Welding (GMAW)**

Duration: Total 12 hours Theory 6 hours Practical 6 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0338.06, 0338.07, 0343.05

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to Gas Metal Arc Weld on light gauge metal.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

15.1.1 Describe the preparation of a joint or seam to be Gas Metal Arc Welded and equipment set-up.

15.1.2 Produce a Gas Metal Arc Weld on various shapes and positions.

**LEARNING CONTENT:**

**15.1.1 Describe the preparation of a joint or seam to be Gas Metal Arc Welded and equipment set-up.**

(6/0) Proper fit of components to be welded:

- gap spacing
- lap joint ferrous and nonferrous
- cleaning of material

Safety:

- Occupational Health and Safety Act
- shop safety when working with compressed gases

Proper safety attire:

- gloves
- aprons

Protection against reflective glare:

- helmet (lens shading)
- sleeves and jackets
- ventilation

Equipment set-up for ferrous and nonferrous:

- gas required
- gas pressure
- wire diameter
- wire load
- weld amperage

**15.1.2 Produce a Gas Metal Arc Weld on various shapes and positions.**

(0/6) - weld collars on fittings

- weld branch in fitting
- weld gore seams

**S1715.2 Gas Tungsten Arc Welding (GTAW)**

Duration: Total 12 hours Theory 6 hours Practical 6 hours

Cross Reference to Training Standards: 0338.01, 0338.02, 0338.03, 0338.06, 0338.07, 0343.07

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**GENERAL LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to* demonstrate the ability to Gas Tungsten Arc Weld on light gauge material.

**LEARNING OUTCOMES**

*Upon successful completion the apprentice is able to:*

15.2.1 Describe the preparation of a joint or seam to be Gas Tungsten Arc Welded and equipment set-up.

15.2.2 Produce a Gas Tungsten Arc Weld on various shapes and positions.

**LEARNING CONTENT:**

**15.2.1 Describe the preparation of a joint or seam to be Gas Tungsten Arc Welded and equipment set-up.**

- (6/0)
- cleaning of ferrous and nonferrous material
  - proper fit of components to be welded

Safety:

- Occupational Health and Safety Act
- related shop safety when working with compressed gas
- proper safety attire
- lens shading
- protection against reflective glare
- ventilation

Equipment set-up:

- gas required
- gas pressure
- tungsten rod
- filler rod
- weld amperage

**15.2.2 Produce a Gas Tungsten Arc Weld on various shapes and positions.**

- (0/6)
- weld collars on fittings for mild steel and stainless steel
  - weld gore seams for mild steel and stainless steel

**Equipment Required For Unit 15**

- Gas Tungsten Arc Welding Machines and consumables
- Gas Metal Arc Welding Machines and consumables

**Equipment Required For Level 3**

- Standard Hand Brake
- Slip Roll Former
- Pittsburgh Roll Former
- Button Lock Roll Former
- Spot Welder
- Groove Seamer
- Rivet Sets, Pop Riveters
- Bar Folder
- Gas Tungsten Arc Welding Machines and consumables
- Gas Metal Arc Welding Machines and consumables
- Ontario Building Code
- CAD Software (Vulcan, Quickpen, Auto-Cad)
- Heat Loss and Gain Software (Writesoft, Carrier)
- Seaming Stakes (hollow mandrel, blow horn, beakhorn, conductor)
- Rotary Turning Machines (elbow edge, burring, turning, wire, beading, crimping, easy edger)
- Box and Pan Brake
- Squaring Shear
- Cheek Bender
- Cut-off Saw
- Grinder
- Uni-shear
- Drill Press, Hand Drills, Drill Bits
- Press Brake
- Soldering Ovens, Soldering Irons, Flux, Solder