

Sheet Metal Worker *On-the-Job Training Guide*

Sheet Metal Workers design, fabricate, assemble, install, and repair sheet metal products required in a wide variety of industries and settings.

Training Requirements: 7200 hours (4 years) including four 8-week training sessions at Saskatchewan Polytechnic in Saskatoon.

Journeyman to apprentice ratio for this trade is: 1:2

*** Any person who is not a journeyman sheet metal worker is required by Regulation to register as an apprentice to work in this trade.**

The information contained in these pages serves as a guide for employers *and* apprentices. Exposure to all aspects of the trade is mutually beneficial to both the employer and the apprentice. The employer's investment in proper training results in a well-rounded worker that is confident in their abilities. The following pages summarize the tasks that should be covered by the apprentice during the on-the-job portion of apprenticeship training. This on-the-job training makes up approximately 85% of the apprentice's skill development. In-school training only serves to expand upon and reinforce skills learned while on the job and is not intended to serve as the sole learning experience of the apprentice for the various aspects of the trade.

As the primary trainer, it is the responsibility of the employer and/or journeyman to train and supervise the practical skills development of an apprentice in all areas of the trade until a satisfactory level of competency has been reached.

EMPLOYER TRAINING RESPONSIBILITY

- encourage a safety-conscious and learning-friendly work environment for all apprentices
- provide a wide variety of tasks for each apprentice to complement their in-school training
- allow time for mentor-apprentice instruction while minimizing productivity losses
- encourage the use of questions and on-going communication between the company, journeymen and apprentices
- provide opportunities for both shop work and jobsite installations
- explain the importance of trade math and demonstrate how it is used on-the-job daily

Employers must commit to making every effort to expose their apprentices to work experience in all areas of the trade.

Information on mentoring and descriptions of responsibilities can be found on our website at www.saskapprenticeship.ca under the *Resources* tab, then selecting *Pamphlets*.

In the following pages, in-school instruction is listed first followed by suggestions to help employers assist the apprentice to prepare for each level of in-school training.

The content of the technical training components is subject to change without notice.

Level One

Trade Theory

Safety equipment and safe work practices
Common sheet metal hand and shop tools and equipment
Types of sheet metal seams, locks and edges
Materials used in the sheet metal industry
Fasteners for sheet metal applications
Fabrication procedures used in shops
Techniques and materials used to solder metals
Factors affecting building ventilation
Architectural systems and accessories
Procedures to rig and hoist materials safely

The employer can assist the apprentice to prepare for this section of technical training by:

- *demonstrating and explaining general trade practices*
- *explaining the relationships between shop work and field installation*
- *giving apprentices many and varied opportunities to learn different tasks*
- *assisting the apprentice to identify the correct hand tools and shop equipment used for various tasks*
- *having a board displaying the different types of knots and having the apprentice practice tying them*
- *describing and demonstrating the types and application of different knots during on-the-job situations*
- *having the apprentice identify seams by cross-section sketching*
- *describing the components used on a basic ventilation job and how each component works*
- *continuously explaining why the apprentices are doing what they are doing*

Bench and Shop Work

Selection of tools and machines appropriate to applications
Operation of powered metal forming equipment
Forming seams, locks and edges
Fabricating basic sheet metal items using simple layout procedures
Using a spot welder to join sheet metal components
Assembly of a section of duct complete with takeoffs
Lay out various degrees of rectangular elbows using basic layout methods
Fabricating regular and ogee offsets using basic layout methods

The employer can assist the apprentice to prepare for this section of technical training by:

- *providing apprentices with opportunities to gain shop experience in a variety of positions*
- *explaining seams, locks and edges*
- *demonstrating simple layouts*
- *assisting to fabricate square to round transitions*
- *promoting safety when welding in the sheet metal shop*
- *providing opportunities to learn theory and practical applications for plasma cutting*

Pattern Drafting

Drafting tools used to make drawings
Types of lines, angles and lettering used for drawings
Pictorial drawings and orthographic projections
Terminology associated with drafting
Views used in the sheet metal industry
Using geometric principles to construct lines, angles and common shapes used in layout work
Two methods of marking patterns in the shop
Making orthographic drawings from pictorial drawings
The three main methods of pattern development

Lay out patterns for sheet metal fittings using basic layout
Lay out patterns for rectangular elbows
Develop patterns for regular and transitional cheek ogee offsets
Lay out patterns for rectangular to round fittings by triangulating from the plan view
Using the parallel line method of pattern development to lay out mitred fittings
Using the radial line method to develop patterns for round to round centered tapers

The employer can assist the apprentice to prepare for this section of technical training by:

- *explaining proper measurement procedures*
- *explaining layout procedures*
- *always having the apprentice verbally repeat the steps necessary to draft a pattern*
- *explaining the use of blueprints and other trade drawings*
- *letting the apprentice do simple layout and graduate them to more difficult projects*

Math

Using basic mathematics
Using basic algebra
Using metric units

The employer can assist the apprentice to prepare for this section of technical training by:

- *providing charts and tables covering these aspects of math for the apprentice to study and refer to when needed*
- *demonstrating the use of a sheet metal ruler and provide charts for this also*
- *allowing apprentices to be included in achieving calculations*
- *having the apprentice perform the metric to imperial conversions for the sizing of ducts from blueprints*
- *explaining why, when, where and how specific equations and formulas are required to be used*
- *reviewing trade math concepts and identifying why, when and how to use them*

Level Two

Residential Mechanical Ventilation

Factors that influence indoor air quality (IAQ)
Interpretation of codes and standards related to residential mechanical ventilation sizing a ventilation system

The employer can assist the apprentice to prepare for this section of technical training by:

- *demonstrating the sizing of ductwork using Ductulator*
- *demonstrating and monitoring for proper duct installation*
- *describing the problems that can arise from improper installations*
- *continually pointing out bad installation practices wherever and whenever they are found*
- *teaching and demonstrating duct testing practices*

Trade Theory

HVAC system categories and components including package units, built up systems and terminal units
Conditions that create airflow in ductwork
Interpretation of the air friction chart to establish cubic feet per minute (CFM), air velocity, friction loss and duct diameter
Purpose of performing testing, adjusting and balancing (TAB)
Components and subsystems within a material handling system
How costs are calculated in bidding a job
Tools, equipment and manpower requirements to install HVAC and architectural systems and components
Preparation for ductwork installations

Characteristics of anchors and hangers used to install ductwork
Characteristics of fire and smoke dampers (use, operation, installation and classification)
Interpretation of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) duct fabrication standards
Interpretation of information related to chimneys and vents

The employer can assist the apprentice to prepare for this section of technical training by:

- *describing bidding and job costing procedures*
- *demonstrating proper duct installation*
- *explaining the importance of fire and smoke dampers*
- *describing energy recovery ventilators*

Bench and Shop Work

Safe operation of powered shop equipment
Setup of powered machinery to perform basic operations
Operation of a power press brake to form various types of metal to specific shapes
Operation of the notching and punching stations on an iron worker
Cutting structural steel shapes using a horizontal band saw
Tapping holes in metal components for specified machine screws
Rolling heavy gauge sheet metal to various diameters using power rolls
Fabricating components from pictorial drawings using the appropriate powered equipment
Fabricating a round tee using parallel line development
Lay out round elbows using the mitre rise method
Using the six point method of triangulation to fabricate a drop cheek elbow
Fabricating a change ogee offset using the combined methods of basic layout and triangulation
Lay out rectangular transitions using triangulation
Threading holes to accommodate various threaded fasteners

The employer can assist the apprentice to prepare for this section of technical training by:

- *allowing apprentices to perform hands-on work in a shop environment*
- *explaining the use of round tees, elbows and offsets*
- *describing architectural sheet metal*
- *supervising hands-on learning with shop equipment*
- *always having books and other materials available to show examples and procedures*

Pattern Drafting

Identification of various round tees and their parts
Identification of various round elbows and their parts
Calculation of roof pitch and rise for various roof jacks
Determining true length triangles for various rectangular transitions
Identification of drop cheek characteristics from a single view shop ticket
Calculation of the swing points and the wrapper lengths of change ogee offsets
Lay out patterns for 90° and angled tees using parallel line development
Develop patterns for round elbows using the elevation and plan view
Using trigonometry and the mitre rise method to make stacked gore patterns for round elbows
Lay out patterns for a three piece round offset
Using the six point method to develop patterns for transitional drop cheek elbows
Lay out inside patterns for change ogee offsets
Develop patterns for rectangular transitions from a specified shop ticket

The employer can assist the apprentice to prepare for this section of technical training by:

- *demonstrating how different components are drafted*
- *explaining which methods are used to draft specific fittings*
- *having the apprentice draw and send in shop drawings for fabrication, monitoring for correctness and completeness*
- *demonstrating and then allowing the apprentice to make fittings*

Print Reading

Identification of isometric, oblique and perspective drawings
How plans and specifications are used by the sheet metal worker
Preparing scaled and freehand isometric and oblique drawings
Interpreting plans and specifications

The employer can assist the apprentice to prepare for this section of technical training by:

- *introducing how and why information is gathered from blueprint materials*
- *explaining how different drawings are used on the job for this trade*
- *explaining how information is transferred from one drawing to another and used to coordinate among other trades*
- *identifying scales and how they are used to convert drawings into real measurements*
- *explaining how to determine areas from drawings*
- *having the apprentice study the drawings for current projects that are in progress and having them relate what they see to the actual site*

Welding

Hazards related to cutting and welding processes
Selection of personal protective equipment
Operation of oxy-acetylene cutting equipment
Operation of shielded metal arc welding (SMAW) equipment

The employer can assist the apprentice to prepare for this section of technical training by:

- *demonstrating and demanding safe welding practices and the use of PPE*
- *allowing for hands-on practice with the different cutting and welding processes*

Electrical

Electrical terminology: voltage, current, resistance and power
The four components of an electrical circuit
The operation of a standing pilot appliance
Performing electrical calculations using the Ohm's Law
Measure resistance, voltage and current
Calculation of voltage, current and resistance (given two values - determine the missing value)

The employer can assist the apprentice to prepare for this section of technical training by:

- *introducing apprentices to electrical systems*
- *introducing apprentices to the proper use and applications of tools used to measure electrical systems*
- *allowing the apprentice to attend classes put on by suppliers*
- *describing and having the apprentice read applicable codes*
- *describing and demonstrating the basic wiring of components*
- *explaining the sequence of operation for a heating unit*
- *explaining how each component works and relates to each other*
- *demonstrating how to diagnose problems*
- *having the apprentice go out on calls with the journey person tech*

Math

Performing Imperial conversions between fraction and decimal length measurements
Using the Right Triangle Formula
Performing trade calculations
Application of basic trigonometry to solve right triangle problems

The employer can assist the apprentice to prepare for this section of technical training by:

- *having the apprentice perform many metric to imperial and back again conversions until understanding of the procedures are second nature*
- *continuously explaining when and how math formulas used and applied in this industry*
- *having the apprentice convert drawings from metric to imperial to come up with an order list*
- *allowing opportunities to use this math for all aspects of the trade such as shop fabrication, ordering materials, etc.*
- *relating trade math to hands-on/real-world situations*

Trade Science

Structure and properties of matter
Different forms of matter
Chemical reactions
Kinetic molecular theory
Heat energy and heat transfer
Problems involving simple machines

The employer can assist the apprentice to prepare for this section of technical training by:

- *explaining how science affects outcomes of the work done by this trade*
- *explaining why different metals don't work together*
- *providing on-the-job examples to show how galvanic reaction is avoided*
- *providing on-the-job examples of combustion air ducts and how they work*

Level Three

Residential Heat Loss/Gain Calculations

Comfort principles of heating and air conditioning
Calculation of the heat loss through residential structures
Calculation of the heat gains through residential structures
Calculation of outside air infiltration
Calculation of ventilation requirements

The employer can assist the apprentice to prepare for this section of technical training by:

- *explaining how conduction, ventilation and leakage contribute to heat transfer in buildings*
- *giving the apprentice calculation sheets and having them size heating and/or cooling appliances for residential applications*
- *clearly demonstrating and then overseeing the apprentice performing heat loss and heat gain calculations for current projects*

Trade Theory

Comparison of HVAC systems and components
Properties of air
Ventilation
Analyzing air flow in ductwork
Categorizing fans used in HVAC systems
Analyzing HVAC duct systems
Characteristics of heat
Characteristics of cooling systems
Duct design characteristics
Comparing duct sizing methods
Field measuring principles
Analyzing hoisting and rigging operations
HVAC equipment and installations
Automatic control systems
Sign work

The employer can assist the apprentice to prepare for this section of technical training by:

- *reviewing all types of airflow calculations with the apprentice*
- *allowing for practical, hands-on training with HVAC components*
- *demonstrating correct hoisting and rigging operations*
- *ensuring all safety procedures and practices are known and used*
- *consistently reviewing the apprentice's work and offering constructive criticism*

Bench and Shop Work

Hazards related to the use of powered fabrication equipment

Operational characteristics of powered fabrication equipment

Operational characteristics of a power press brake

Gas metal arc welding (GMAW) operations

Safe operation heavy gauge fabrication equipment including the press brake and the iron worker

Fabrication of metal parts using heavy gauge fabrication equipment

Fabrication of fittings using the radial line method of pattern development

Fabrication of fittings using the elevation view method of triangulation

Fabrication of mitred sheet metal components using the parallel line method

Field measurement of a given spouting system

Fabrication of a spouting system

The employer can assist the apprentice to prepare for this section of technical training by:

- *requiring all apprentices to rotate through the performing of all shop work with a competent qualified journeyperson*
- *guiding the apprentice through the various fittings*
- *demonstrating and assisting the apprentice to lay out a square-to-round on a pitch and a "Y" branch*

Pattern Drafting

Radial line development

Square to round layout using triangulation from an elevation view

Layout using a combination of drafting methods

Layout of Y branches using the elevation view method

Layout of mitres and rake mitres using the parallel line method

Lay out patterns for oblique round tapers using the radial line method

Lay out patterns for pitched tapers using the radial line method

Lay out patterns for pitched square to rounds using the elevations view method of triangulation

Lay out patterns for 3-piece square to round using parallel lines and the elevation view method of triangulation

Lay out patterns for 7-branch using the elevation view method of triangulation

Lay out patterns for mitred components using the parallel line method

Lay out patterns for rake mitres using the parallel line method

The employer can assist the apprentice to prepare for this section of technical training by:

- *describing the different ways to develop patterns during drafting*
- *demonstrating the use of advance pattern drafting in shop production*
- *allowing the apprentice many opportunities to fabricate all types of fittings*

Print Reading

Distinguishing between the different types of drawings found in a set of prints

Civil drawings and specialty areas

Differentiating between architectural, structural and electrical drawings

Mechanical drawings

Shop drawings

Interpretation of information from plans and specifications

Interpretation of information from mechanical prints

Performing a takeoff from a shop drawing

The employer can assist the apprentice to prepare for this section of technical training by:

- *supervising the reading and application of prints and shop drawings*
- *allowing the apprentice to read and interpret all types of drawings*
- *having the apprentice make fabrication lists from blueprints*

Welding

Preparing for gas metal arc welding (GMAW) operations

Selection of protective equipment

Operate GMAW equipment for welding operations

The employer can assist the apprentice to prepare for this section of technical training by:

- *if necessary, send the apprentice to after-hours welding training*
- *allowing for hands-on practice with different welding and processes*

Mathematics

Basic mathematics and algebra

Performing calculations involving trade applications

Application of basic trigonometry to solve trade problems

The employer can assist the apprentice to prepare for this section of technical training by:

- *providing on-site demonstrations of offset calculations, hangar spacing, elevations, etc.*
- *constantly requiring the apprentice to apply different maths to on the job practices*
- *assisting apprentices in the shop to learn and apply formulas for wrappers, etc.*
- *assisting the apprentice to measure a duct run containing an offset*
- *having the apprentice calculate supply air volume in a particular room and getting them to compare to square footage*
- *ensuring that the apprentice understands the right triangle formula and can apply it to real-work situations*
- *demanding that the apprentice to review their math notes from previous training and testing them on it*

Trade Science

Properties of various materials

Concepts of thermodynamics

Application of concepts of Psychrometry

Using qualitative and quantitative methodology pressure concepts in static and dynamic situations

Heat energy and heat transfer

Solving problems involving simple machines

The employer can assist the apprentice to prepare for this section of technical training by:

- *training the apprentice to balance and test duct systems for CFM and velocity*
- *describing how heavy appliances and components can be moved using different types of mechanical advantage*
- *explaining how heat transfers through various components of a building envelope*
- *ensure that all types of pressure measuring equipment is understood, used and maintained properly*

Level Four

Residential Air System Design

Sizing system components to meet the requirements of existing codes and standards

Determining air flow rates from equipment specification sheets

Calculation of mixed air temperatures

Calculation of external static pressure from equipment specifications sheets

Designing a residential air distribution system

The employer can assist the apprentice to prepare for this section of technical training by:

- *having the apprentice design a duct package from a residential blueprint and complete the room-by-room heat loss-heat gain calculations*
- *having the apprentice determine equipment and duct selection from a current project that is not a design project*
- *asking apprentices to review fan specifications and having them describe how this relates to the size of duct running to and from the fan*

Trade Theory

Analyzing industrial sheet metal
Comparison of industrial material handling systems
Blowpipe systems
Industrial specialties related to sheet metal work
Duct leakage testing
Testing, adjusting and balancing work
Commissioning a building
Examination of indoor air quality
Comparison of filtration and air cleaning equipment
Special ventilation needs
Commercial refrigeration systems
How automatic controls function in HVAC systems
Fabrication and installation procedures related to boiler breeching
Planning and running jobs

The employer can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice understands how to use measuring instruments such as velometer, anemometer and pitot tube*
- *explaining the importance of ventilation as it relates to air quality*
- *describing and demonstrating the procedures used to work on refrigeration systems such as recharge and recover refrigerant; perform pump down and system purge; and find and repair leaks*
- *describing and demonstrating the procedures used to balance HVAC systems*
- *describing exhaust systems used for the removal of industrial contaminants including recommended fabrication and installation practices for fume and dust removal*
- *discussing alternate applications for sheet metal products*

Bench and Shop Work

Shop safety
The gas tungsten arc welding (GTAW) process
Calculation of a bend allowance using the empirical formula
Fabricating complex fittings using the triangulation method
Fabricating complex fittings using the parallel line method
Fabricating complex fittings using the radial line method
Using a combination of drafting methods to fabricate various fittings
Calculation of bend allowances using the empirical method and then form the part

The employer can assist the apprentice to prepare for this section of technical training by:

- *consistently setting the apprentice have shop time in order to improve skills*
- *supervising from a distance, offering suggestions for improvement*
- *having the apprentice write out the steps necessary to complete a project before beginning*
- *assisting with hands-on experience at GTAW welding*
- *giving a simple exercise to practice GTAW welding such as a stainless steel drain pan*

Pattern Drafting

Performing calculations related to change ogee offsets
Performing calculations related to drop cheek elbows
Calculation of the cut size of round elbows
Calculation of panel lengths for a rectangular transition from a single view
Draft complex fittings using the triangulation method
Draft complex fittings using the parallel line method
Draft complex fittings using the radial line method
Use a combination of drafting methods to draw various fittings

The employer can assist the apprentice to prepare for this section of technical training by:

- *consistently setting the apprentice have shop time in order to improve skills*
- *reviewing pattern drafting prior to level four intake*

Print Reading

The importance of prints and specifications in the construction industry
Interpreting information found in prints and specifications
Producing a shop print for a given blow pipe system
Performing a takeoff from a shop drawing

The employer can assist the apprentice to prepare for this section of technical training by:

- *breaking down detailed drawings into explainable portions*
- *asking specific questions to ensure understanding of the various drawings and specifications*
- *reviewing drawings and specifications for all projects the apprentice is working on to point out special circumstances, notes and details that the apprentice must learn to look for and recognize*

Welding

Preparing a work area for welding operations
Selection of personal protective equipment
Operate gas tungsten arc welding (GTAW) equipment

The employer can assist the apprentice to prepare for this section of technical training by:

- *ensuring that a clean safe workstation is maintained and that appropriate PPE is consistently used*
- *allowing for hands-on practice with different welding processes*
- *describing the importance of cleanliness and the causes of metal contamination*

Electrical

Operation of a standing pilot appliance
Electrical components used in modern appliances
Sequence of operation for an intermittent pilot appliance
Sequence of operation for a direct spark ignition appliance
Sequence of operation for a hot surface ignition appliance
Measuring voltage, current and resistance in a standing pilot appliance
Measuring voltage, current and resistance to confirm the operation of electrical controls found in an appliance

The employer can assist the apprentice to prepare for this section of technical training by:

- *taking the apprentice on service calls and demonstrating the process of troubleshooting*
- *ensuring that the sequence of operation is clearly understood*
- *having the apprentice trouble-shoot heating appliances in the field*
- *allowing opportunities to perform an installation from start to finish*
- *allowing the apprentice to further their education by attending supplier training whenever available*

Trade Mathematics

Basic mathematics and algebra

Performing calculations involving trade applications

Application of basic trigonometry to solve trade problems

The employer can assist the apprentice to prepare for this section of technical training by:

- *continually forcing the apprentice to perform all calculations in the field*
- *reviewing previous math training to ensure comprehension*
- *noticing and ensuring that all aspects of the trade's math is now second nature*

Communications

Application of job-related interpersonal and oral communications

Principles of customer service

Preparation of workplace documents

The employer can assist the apprentice to prepare for this section of technical training by:

- *ensuring that the expectations for behaviour at the worksite and shop are clearly understood*
- *ensuring that the employer and supervisors all practice the same objectives that the apprentice is expected to follow*
- *treating apprentices with the same respect that they are expected to show to others*
- *having the apprentice perform the ordering of materials*
- *having the apprentice make out pick lists*
- *allowing the apprentice to interact with site superintendents, foremen and engineers in order to ask pertinent questions*

Consider apprenticeship training as an investment in the future of your company and in the future of your workforce. Ultimately, skilled and certified workers increase your bottom line.

Get involved in the apprenticeship training system. Your commitment to training helps to maintain the integrity of the trade.

Do you have employees who have been working in the trade for a number of years but don't have trade certification? Contact your local apprenticeship office for details on how they might obtain the certification they need.

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