SUSTAINABLE ESSENTIAL SKILLS

Trades Worksheets Book Three

BUILDFORCE CANADA

SKILLPLAN

Introduction

What is the purpose of this collection of worksheets?

These worksheets are part of a project to encourage integrating Essential Skills into technical training. The worksheets address competencies that are outlined in the National Occupational Analysis and are part of every trades training curriculum, regardless of region or level. The content originated in trades training curricula but is enhanced with features that make Reading, Document Use and Numeracy tasks transparent.

The purpose of this collection of worksheets is to

- provide ready-made materials for instructors to use
- model an Essential Skills approach that integrates Essential Skills strategies into technical training topics
- provide a means to assist apprentices who find technical training difficult

Who should use these worksheets?

Technical instructors can decide which worksheets are appropriate for individual apprentices, study groups and classes. Educators in settings that prepare students for apprenticeship or who have an interest in work-related applications may find some worksheets appropriate.

Why use these worksheets?

Each worksheet activity was suggested and reviewed by an experienced trades instructor. The trades topics are useful for more than one trade. For example, several trades use fan laws; however, this topic is only discussed in one of the workbooks under one trade.

The worksheets provide practice and strategies to reinforce concepts instructors present in class. Instructors can use them with apprentices to review and to teach using a clear process that can become a transferable strategy. The activities have been carefully selected to identify technical training topics that are problematic for apprentices.

Integrating Essential Skills into worksheets helps apprentices develop transferable skills including:

- locating and integrating information from complex text and information displays that use technical terms, abbreviations and symbols
- translating problems into mathematical operations using several steps of calculation and a combination of formulae

How can the worksheets be used?

The worksheets are arranged in three workbooks ordered alphabetically by trade. A complete listing of the topics in all three workbooks is on the back inside cover.

Instructors can choose worksheets as they fit into their curriculum or to supplement existing study materials or as a class learning activity. Worksheets can also be used with apprentices who need extra practice.

Instructors can also look beyond the topic and examine the layout and concepts addressed. They can develop their own content using these ideas to integrate the Essential Skills appropriate for their apprentices and trade application.

How can instructors participate in this project?

These workbooks and accompanying instructor's guide are part of a project to integrate Essential Skills into technical training. You are invited to join the growing community of technical training instructors who are learning more about Essential Skills and how this approach can facilitate effective trades training and increase success for more apprentices.

Here is how you can participate now and in the future:

- Download copies of these workbooks and other related publications at www.buildforce.ca.
- Use these materials with your apprentices
- Design your own materials using the same Essential Skills features

The completed project envisions a virtual community of technical training instructors who will post their own worksheets and other materials to share with instructors across Canada. There will be opportunities for networking online, a 1-800 information service, and instructor training courses. The goal of these initiatives is to inspire instructors to add to their credentials by meeting the requirements of a formal Essential Skills endorsement program.

Table of Contents

Refrigeration and Air Conditioning Mechanics

Refrigeration Mechanics make, install, repair and service residential, commercial and industrial cooling and heating systems in supermarkets, restaurants, office buildings, manufacturing facilities, hospitals and other structures. They recharge systems with refrigerant gases as required. They also connect rooftop units to gas, test and balance systems and connect electrical systems.

Activities

There are five activities in this section. Two activities provide strategies and application of the Fan Laws.
Three activities provide practice locating and applying information in the B52-05 Mechanical Refrigeration Code.

- Understanding Fan Laws
- Using Fan Laws on the Job
- Using the B52-05 Mechanical Refrigeration Code
- Determining Pressure Relief Valve Requirements
- Determining Discharge Piping Size

National Occupational Analysis (NOA)

The NOA has identified the following tasks as being required for a fully competent tradesperson in this trade:

- Interprets tables, charts and diagrams.
  - Knowledge of types of refrigeration tables, charts and diagrams
  - Knowledge of refrigeration and electrical and gas, acts, codes, legislation, regulations and specifications
- Complies with government acts, codes, standards and regulations.
  - Ability to apply standards, codes and regulations
- Confirms heating, ventilating and air conditioning requirements.
  - Ability to calculate air flow/air quality requirements

Essential Skills Highlights

These activities combines Reading, Document Use and Numeracy at Level 4.

Reading and Document Use

- Locate and integrate multiple pieces of information in complex text and information displays including tables
- Use specialized knowledge such as trade terms and abbreviations

Numeracy

- Make multiple steps of calculation
- Translate problem into a set of mathematical operations using several steps of calculation and a combination of formulae

Understanding Fan Laws

Fan laws are equations stating the relationship between existing fan conditions (old) and desired fan conditions (new). A fan operating in a given system moves a definite volume of air through the system. If, for example, the speed (RPM) of the fan is increased or decreased, the volume (CFM) of air moving through the system changes in proportion. The static pressure (SP) and brake horsepower (BHP) will also change in proportion.

Fan Law #1

This is a proportion that compares cubic feet per minute (CFM) to revolutions per minute (RPM). If the CFM increases, the RPM increases proportionately. If the CFM decreases, the RPM decreases.

$$\frac{CFM_{new}}{CFM_{old}} = \frac{RPM_{new}}{RPM_{old}}$$

Example:

old cfm ↓ old rpm ↓ new rpm ↓

A fan is producing 19 750 cfm at 785 rpm. If the rpm is changed to 700 rpm, how many cfm will be produced?

↑ new cfm

$$\frac{CFM_{new}}{CFM_{old}} = \frac{RPM_{new}}{RPM_{old}}$$

$$\frac{CFM_{new}}{19\ 750} = \frac{700}{785}$$

$$\frac{19\ 750 \times 700}{785} = \frac{13\ 825\ 000}{785} = \textbf{17 611.5 cfm}$$ rounded off to one decimal place

Fan Law #2

The following two equations are used to calculate the static pressure (SP) a fan will produce after the RPM or CFM is changed. You can use either CFM or RPM to calculate SP. Static pressure varies directly as the square of the RPM or CFM. If the CFM or RPM increases the SP increases.

$$\frac{SP_{new}}{SP_{old}} = \left(\frac{CFM_{new}}{CFM_{old}}\right)^2 \qquad \frac{SP_{new}}{SP_{old}} = \left(\frac{RPM_{new}}{RPM_{old}}\right)^2$$

7) The static pressure increases from 0.625” to 0.977”. The rpm was 352 rpm. What is the new rpm?

8) The bhp at 13 200 cfm is 12.5 bhp. Calculate the new bhp requirement at 16 325 cfm.

9) The bhp at 17 500 cfm is 15 bhp. Calculate the new bhp requirement at 20 000 cfm.

10) The bhp at 7 650 cfm was 9. Calculate the new cfm if the bhp is changed to 12.

11) A fan is delivering 10 710 cfm at 474 rpm. The bhp is 5.6. Static pressure is 1.75". The cfm must be changed to 8 450.

a) What is the new rpm?

b) What is the new sp?

c) What is the new bhp?

Using Fan Laws on the Job

This exercise is an example of applying fan laws to a typical job problem.

The column titled Specifications gives the CFM, RPM, SP and HP as designed by the engineer.

The Air Balance Report does not meet the original specifications. The CFM is significantly less than the specifications. The SP is higher than the specifications. This is most likely because the ductwork was more restrictive than the original design. Because the CFM is less than the specifications, the HP is also less than the specifications.

	Specifications	**Air Balance Report**	**15 000 CFM**	**Fully Loaded Motor**
CFM	15,000	12,000	15,000	
RPM	900	900		
SP	2.3	2.7		
HP	15	9		15

Use the information in the table to calculate the following. Enter the answers in the table.

1) Complete the 15,000 cfm column in the table. Calculate the required rpm, sp, and hp to get the 15,000 cfm that was originally specified.

2) Calculate the conditions if the 15 hp motor is fully loaded. If the final airflow is within 10% of spec, the engineer will likely okay the job. Enter the calculations in the Fully Loaded Motor column.

The three activities in this section all use the B52-05 Mechanical Refrigeration Code.

Using the B52-05 Mechanical Refrigeration Code

The questions for this worksheet can be answered using Section 7 of the B52-05 Mechanical Refrigeration Code.

Refer to pages 19 to 23 in this workbook

Determining Pressure Relief Valve Requirements

The questions for this worksheet can be answered using Section 7 of the B52-05 Mechanical Refrigeration Code.

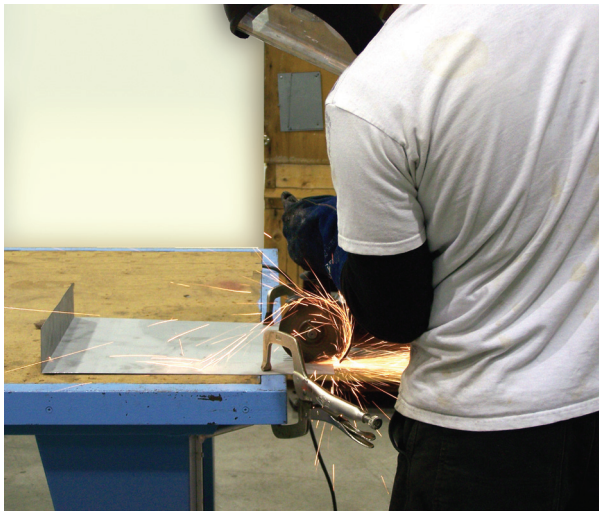
Refer to pages 19 to 21 in this workbook

Determining Discharge Piping Size

The questions for this worksheet can be answered using Section 7 of the B52-05 Mechanical Refrigeration Code.

Refer to pages 22 to 23 in this workbook

Sheet Metal Workers



Sheet Metal Workers assemble, install and service an extensive range of heating, air conditioning, roofing, restaurant, and hospital equipment. This includes such items as: ducts, pipes, gutters, cabinets, flashings and supporting devices. Sheet Metal Workers are employed by sheet metal fabrication shops, sheet metal manufacturing companies, sheet metal work contractors and various industrial sectors.

Activities

The two activities practice calculating offsets using two different methods.

- Calculating Offsets
  Uses trigonometry to calculate offset for any size elbow.
- Calculating the Length of Straight Duct
  Uses trigonometry constants to calculate the length of straight duct for 30°, 45° and 60° elbows

National Occupational Analysis (NOA)

The NOA has identified the following tasks as being required for a fully competent tradesperson in this trade:

- uses measuring and layout equipment
  - Knowledge of geometry and trade related mathematics
- pattern development requires knowledge of mathematical formulas

Essential Skills Highlights

These activities combine Document Use and Numeracy skills at Level 4.

Document Use

- Integrate information from a photograph and a table
- Use specialized knowledge such as trade terms and abbreviations
- Locate and enter information into a table

Numeracy

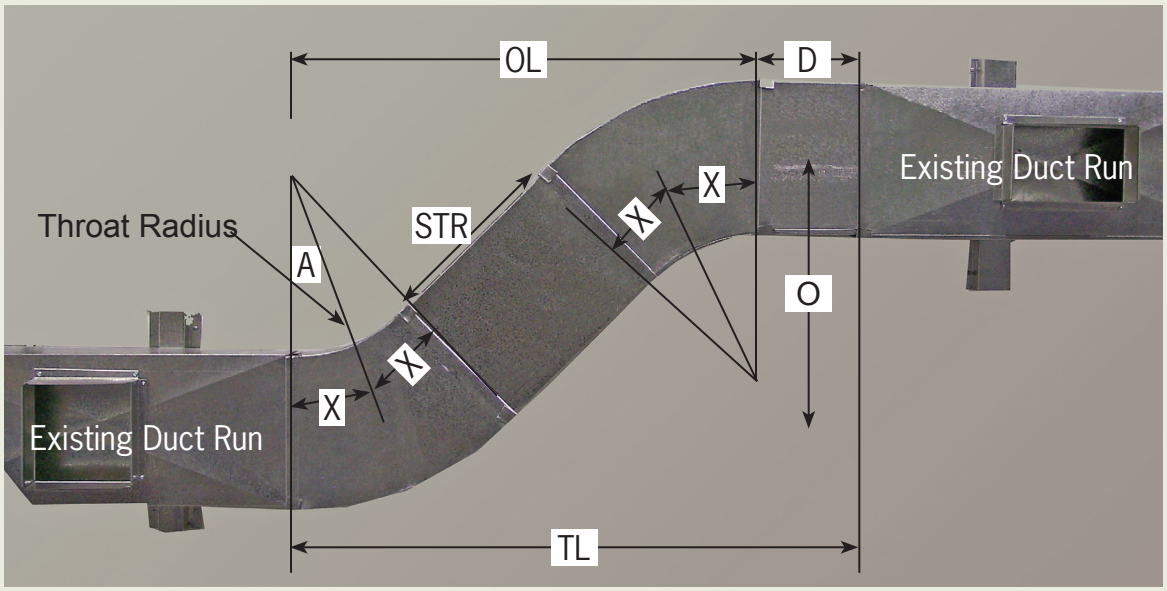
- Make multiple steps of calculations
- Use considerable translation to turn a problem into a set of mathematical operations using a combination of formulae

Calculating a Given Elbow Offset

This example shows how to calculate:

- the length of straight duct between two given elbows to achieve the desired offset
- the length of the finished offset to determine if duct will be added or subtracted to the final overall connection.

Example: Calculate the centreline radius, knuckle, offset length, straight duct and required duct for the following. All measurements are in inches. Round off answers to three decimal places.



Duct Diameter or Width	**A** Angle of Elbow	Throat Radius	**TL** Total Length	**O** Offset Required	**CL Rad** Centre Line Radius	**X** Knuckle	**OL** Offset Length	**STR** Straight Duct	**D** Required Duct
18"	45°	27"	123"	112"					

Step 1: Calculate the Centreline Radius (CL Rad)

CL Rad

= Throat Radius + distance from edge of duct to centreline of duct

= 27" + 9" = **36.00"**

Step 2: Calculate the Knuckle (X).

$X = \text{Centreline Radius} \times \tan\left(\frac{\text{angle}}{2}\right)$

$= 36.00'' \times \tan\left(\frac{45}{2}\right)$

$= 36.00'' \times 0.414213562 =$ **14.912"**

Step 3: Calculate the Offset Length (OL).

$OL = \frac{\text{offset}}{\tan A} + 2(X) = \frac{112}{\tan 45} + 2(14.912'')$

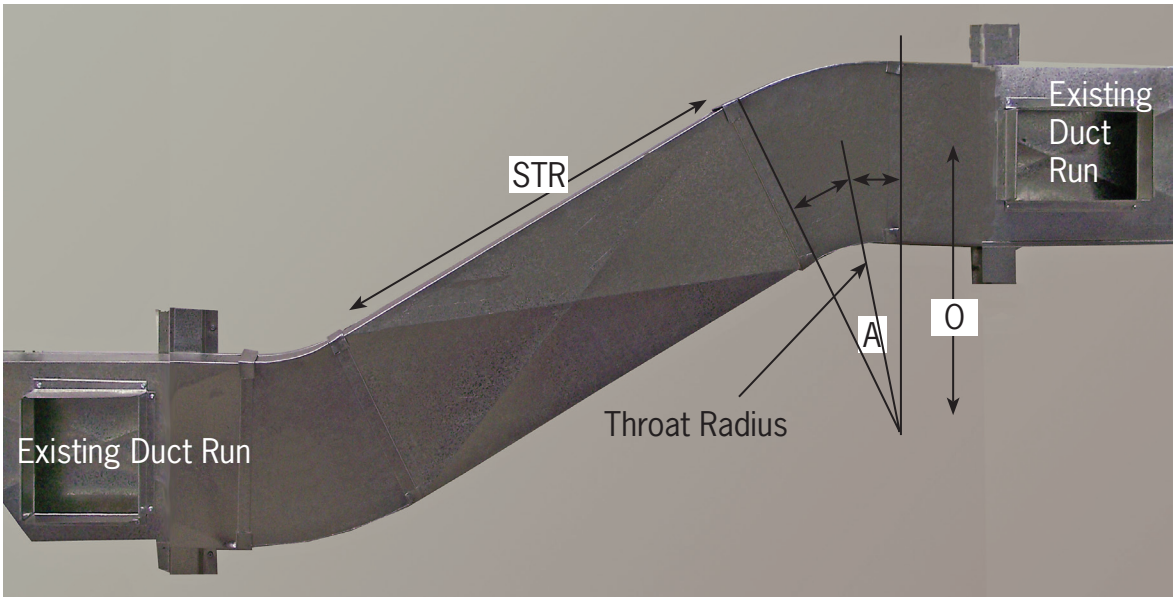
$= 112'' + 29.824'' =$ **141.824"**

Using Constants to Calculate the Length of Straight Duct

Most offsets use 30°, 45°, 60° or 90° elbows. The formulas listed below can be used to calculate the straight duct required to achieve the desired offset using 30°, 45° and 60° elbows.

30° elbows

Length of straight duct = (offset × 2) – (2 × CL radius × 0.268)



Example 1:

Calculate the straight duct required to achieve the desired offset.

Duct Diameter or Width	**A** Angle of Elbow	Throat Radius	**O** Offset Required	**CL Rad** Centre Line Radius	**STR** Straight Duct
10"	30°	5"	23"	**10"**	**40.64"**

Step 1: Calculate the Centreline Radius (CL Rad)

CL Rad = Throat Radius + half the duct width

$= 5" + \frac{10}{2}$

$= 5" + 5" =$ **10"**

Step 2: Calculate the straight duct required.

Length of straight duct = (offset × 2) – (2 × CL radius× 0.268)

= (23" × 2) – (2 × 10"× 0.268)

= 46" – 5.36" = **40.64"**

Practice

Calculate the straight duct required to achieve the desired offset.

1)

Duct Diameter or Width	**A** Angle of Elbow	Throat Radius	**O** Offset Required	**CL Rad** Centre Line Radius	**STR** Straight Duct
14"	60°	7"	48"		

2)

Duct Diameter or Width	**A** Angle of Elbow	Throat Radius	**O** Offset Required	**CL Rad** Centre Line Radius	**STR** Straight Duct
12"	30°	6"	57"		

3)

Duct Diameter or Width	**A** Angle of Elbow	Throat Radius	**O** Offset Required	**CL Rad** Centre Line Radius	**STR** Straight Duct
16"	45°	16"	40"		

Wall and Ceiling Installers

(Also known as Lather or Interior Systems Mechanic)

Wall and Ceiling Installers install, handle, erect and apply materials that are component parts in the construction of ceilings and walls. They install support frameworks for ceiling systems, interior and exterior walls and building partitions to prepare for the installation of drywall or plaster walls and ceilings. They also install curtain walls, perform acoustical installations, and install shielded walls.

Activities

There are four activities specific to Wall and Ceiling Installers.

- Reading Engineered Drawings
- Locating Information in the Wall and Ceiling Standards Manual
- Using a Drawing to Calculate Missing Dimensions
- Determining Grid Layout

National Occupational Analysis (NOA)

The NOA has identified the following tasks as being required for a fully competent tradesperson in this trade:

- Uses documentation
  - Knowledge of types of documents such as plans, schedules, change orders and specifications
  - Ability to interpret documents such as manuals, manufacturers' specifications, and meeting minutes
- Uses blueprints and drawings
  - Knowledge of different views such as elevation, section and detail
  - Knowledge of components of blueprints and drawings such as symbols, scales and schedules
- Estimates materials and supplies
  - Ability to perform mathematical calculations such as surface area, linear measurement, and quantity requirements in both metric and imperial measurement

  - Ability to interpret site measurements
- Performs measurements
  - Knowledge of formulas such as area, radii and surface area
  - Ability to perform basic mathematical operations
- Lays out work
  - Ability to determine and lay out gridlines
  - Ability to make allowances to achieve finish dimension on walls, ceilings and floors

Essential Skills Highlights

These activities combine Reading, Document Use and Numeracy skills at Level 3.

Reading and Document Use

- Locate and integrate multiple pieces of information in text and information displays including standards, scale drawings, diagrams, tables and legends
- Identify relevant and irrelevant information

Numeracy

- Translate problems into a set of mathematical operations using several steps of calculations and a combination of formulae

Reading Engineered Drawings

Engineered drawings are designed specifically for a job. They provide details about material requirements, assembly and installation. Use the Engineered Drawings on pages 41 to 43 to answer these questions.

Practice

1) What is the colour code for 14 gauge steel on this print?

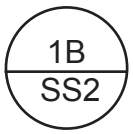
2) What is the deflection top track clearance in mm?

3) What is the seismic load (psf) for a wall with brick facing?

4) The length of the HILTI metal hit anchors must be _____ with minimum embedment of _____ and a minimum spacing of _____.

5) What number and type of screw is assumed for all of the connections unless otherwise specified?

6) What is the difference between 

and 

?

7) List the two choices for bridging.

8) How many rows of bridging are required on a wall that is 22 ft high?

Locating Information in the Wall and Ceiling Standards Manual

Use Section 9.15: Metal Ceiling Systems to answer the following questions.

1) What is the purpose of Part 1 of this section of the standard?

2) Where will you find information about acoustical ceilings?

3) How many types of Ceiling Systems are listed?

4) List the two systems that have not been included in the Guide Specification because of their limited use and availability.

5) How are linear beams attached to the symmetrical suspension carriers in a linear metal ceiling system?

6) What is the purpose of the specially designed liner in the flat lay-in metal tile ceiling system?

7) What is the topic of 3?

8) Which suspension system is most common?

9) Where are intermediate duty systems commonly used?

10) Which ceilings are excluded from the ASTM E580 standard for seismic restraint requirement?

11) What is the objective of ASTM E580?

12) Which reference standard is used for metal suspension systems for acoustical tile and lay-in ceilings?

Using a Drawing to Calculate Missing Dimensions

Use the drawing titled Office Floor Plan to answer the following questions. The walls are 6" thick and 10 feet high.

The scale is ¼ : 1.

1) What are the dimensions of the room labelled CLOSET?

2) Calculate the overall width, including the closet, of the VICE-PRESIDENT'S OFFICE.

3) Use the scale ruler to measure the length of the wall on which the entry door is located of the VICE-PRESIDENT'S OFFICE.

4) Calculate the length of the wall between the closet and the (north) wall in OFFICE #2.

5) If the closet doors are centered in the projection for the closet in OFFICE #2, how much drywall will be on each side of the closet doors?

6) Calculate the height of the drywall over the closet doors in OFFICE #2.