PROGRAM OUTLINE

Industrial Mechanic (Millwright)
INDUSTRIAL MECHANIC (MILLWRIGHT)
PROGRAM OUTLINE

APPROVED BY INDUSTRY
JUNE 2014

BASED ON
NOA 2013

Developed By
Industry Training Authority
Province of British Columbia
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Section 1
INTRODUCTION
Millwright
Foreword

The Program Standards for Millwright 2014 were updated through a Standards Review project funded by the Industry Training Authority.

These revised standards incorporate changes made to the National Occupational Analysis (Millwright) released in 2013. The standards were reviewed and adjusted by a group of Subject Matter Experts (SMEs), during a one day workshop in June 2014. Thanks are extended to SMEs for their dedication and participation in keeping Millwright Program Standards technologically current and aligned with the needs of industry.

SAFETY ADVISORY

Be advised that references to the WorkSafeBC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com. Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.
Acknowledgements

Millwright Standards Project SMEs (2014)

- Gord Balfour  Millwrights, Machine Erectors and Maintenance Union
- Steve Hall    Coast Industrial
- John Byron   BCIT

Key stakeholders from industry sectors including employers, associations, training providers, and trades workers were integral to the guidance of this program development project. Members of the Project Steering Committee who contributed their valuable time and insights to the project were:

- Steve Anderson  Department of National Defense
- Danny Bradford  BC Federation of Labour
- Larry Doskoch   Teck
- Ralph Finch     Thompson Rivers University
- Dana Goedbloed  Kwantlen Polytechnic University
- Wayne Muzylowski West Fraser (Eurocan Pulp and Paper)
- James Piwek     Teck
- Brad Smith      Catalyst Paper
- Cindy Soderstrom CAODC (Rig Tech Trade)
- Gene Von Matt   Elk Valley Coal
- Wayne Wetmore   Enform Training
- Trevor Williams BC Institute of Technology
# How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Program Credentialing Model</strong></td>
<td>Communicate program length and structure, and all pathways to completion</td>
<td>Understand the length and structure of the program</td>
<td>Understand the length and structure of the program, and pathway to completion</td>
<td>Understand challenger pathway to Certificate of Qualification</td>
</tr>
<tr>
<td><strong>OAC</strong></td>
<td>Communicate the competencies that industry has defined as representing the scope of the occupation</td>
<td>Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification</td>
<td>View the competencies they will achieve as a result of program completion</td>
<td>Understand the competencies they must demonstrate in order to challenge the program</td>
</tr>
<tr>
<td><strong>Training Topics and Suggested Time Allocation</strong></td>
<td>Shows proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application</td>
<td>Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application</td>
<td>Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application</td>
<td>Understand the relative weightings of various competencies of the occupation on which assessment is based</td>
</tr>
<tr>
<td><strong>Program Content</strong></td>
<td>Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measurable achievement criteria for objectives with a practical component</td>
<td>Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice</td>
<td>Provides detailed information on program content and performance expectations for demonstrating competency</td>
<td>Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels</td>
</tr>
<tr>
<td><strong>Training Provider Standards</strong></td>
<td>Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program</td>
<td>Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own</td>
<td>Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors</td>
<td>Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment</td>
</tr>
</tbody>
</table>
## Introduction

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix – Glossary of Acronyms</td>
<td></td>
<td></td>
<td>Defines program specific acronyms</td>
<td></td>
</tr>
</tbody>
</table>
Section 2

PROGRAM OVERVIEW

Millwright
Program Overview

Program Credentialing Model

Apprenticeship Pathway
This graphic provides an overview of the Industrial Mechanic (Millwright) apprenticeship pathway.

*C of Q = Certificate of Qualification
*C of A = Certificate of Apprenticeship
*C of C = Certificate of Completion
*WBT = Work-Based Training

RECOMMENDATION FOR CERTIFICATION

Millwright Level 4
Technical Training: 210 hours (7 weeks*)
Work-Based Training: 6,600 hours total
Interprovincial Red Seal Exam

Millwright Level 3
Technical Training: 210 hours (7 weeks*)
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Millwright Level 2
Technical Training: 210 hours (7 weeks*)
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Millwright Level 1
Technical Training: 210 hours (7 weeks*)
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

C of C
Millwright
CREDIT
Technical Training: Level 1
WBT: 425 hours

Millwright Foundation Program
Technical Training: 24 weeks*

APPRENTICESHIP - DIRECT ENTRY

*Suggested duration based on 30-hour week

CROSS/PROGRAM CREDITS
Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program

C of Q
Planermill
Maintenance
Technician 1

Technical Training: Level 1
WBT: None
Program Overview

Occupational Analysis Chart

INDUSTRIAL MECHANIC (MILLWRIGHT)

**Occupation Description:** “Millwright” means a person who dismantles, moves, installs, lays out, sets-up, repairs, commissions, overhauls and maintains all machinery and heavy mechanical equipment, including power transmissions, conveyors, hoists, pumps, compressors, alignment, fluid power and vibration analysis.

<table>
<thead>
<tr>
<th>WORK PRACTICES</th>
<th>Explain Federal/Provincial Occupational Health &amp; Safety Regulations</th>
<th>Use Personal Protective Equipment</th>
<th>Follow Safe Working Practices</th>
<th>Use Communication and Teamwork Skills</th>
<th>Interpret Plans and Sketches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td></td>
<td>A2</td>
<td>A3</td>
<td>A4</td>
<td>A5</td>
</tr>
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</table>

**Use Reference Resources**: W A7

<table>
<thead>
<tr>
<th>TRADE SCIENCE</th>
<th>Use Trade Science</th>
<th>Describe Materials</th>
<th>Explain Simple Machines</th>
<th>Use Fits and Tolerances</th>
<th>Use Fasteners</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td></td>
<td>B2</td>
<td>B3</td>
<td>B4</td>
<td>B5</td>
</tr>
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<td>1</td>
<td></td>
<td>2</td>
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</tbody>
</table>

**Describe Theory of Electricity and Electronics**: B7

<table>
<thead>
<tr>
<th>USE TOOLS</th>
<th>Use Hand Tools</th>
<th>Use Measuring and Layout Tools and Instruments</th>
<th>Use Portable Power Tools</th>
<th>Use Fixed Shop Machines and Equipment</th>
<th>Use Mobile Access Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td></td>
<td>C2</td>
<td>C3</td>
<td>C4</td>
<td>C5</td>
</tr>
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</tr>
</tbody>
</table>

W = Workplace Skill Acquisition

Industrial Mechanic (Millwright)  Industry Training Authority  09/15
<table>
<thead>
<tr>
<th>LUBRICANTS, SEALS AND BEARINGS</th>
<th>INSTALL EQUIPMENT</th>
<th>CUT, FIT AND FABRICATE</th>
<th>MAINTAIN PRIME MOVERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Lubricants</td>
<td>Maintain Lubricating Systems</td>
<td>Select Seals, Gaskets and Packing</td>
<td>Install and Maintain Seals</td>
</tr>
<tr>
<td>D1</td>
<td>D2</td>
<td>D3</td>
<td>W</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>D4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Select Bearings</td>
<td>Install and Maintain Bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>D6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INSTALL EQUIPMENT**

<table>
<thead>
<tr>
<th>Use Safe Rigging Practices</th>
<th>Describe Layout and Securing of Equipment</th>
<th>Describe Equipment Foundations</th>
<th>Explain Levelling and Alignment Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>E2</td>
<td>E3</td>
<td>E4</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**CUT, FIT AND FABRICATE**

<table>
<thead>
<tr>
<th>Describe Welding Practices</th>
<th>Use and Maintain Oxy-Fuel Cutting, Welding and Heating Equipment</th>
<th>Use and Maintain Shielded Metal Arc Welding (SMAW) Equipment</th>
<th>Use and Maintain Plasma Arc Cutting Equipment</th>
<th>Use and Maintain Gas Metal Arc Welding (GMAW) and Gas Tungsten Arc Welding (GTAW) Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>F2</td>
<td>F3</td>
<td>F4</td>
<td>F5</td>
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<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
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</tbody>
</table>

**MAINTAIN PRIME MOVERS**

<table>
<thead>
<tr>
<th>Explain Prime Mover Theory</th>
<th>Describe Electric Motors</th>
<th>Maintain Electric Motors</th>
<th>Describe Internal Combustion Engines</th>
<th>Describe the Maintenance of Internal Combustion Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>G2</td>
<td>G3</td>
<td>G4</td>
<td>G5</td>
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<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Describe the Maintenance of Turbines</th>
<th>Describe Power Turbines</th>
</tr>
</thead>
<tbody>
<tr>
<td>G7</td>
<td>G8</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

W = Workplace Skill Acquisition
# Program Overview

## Service Power Transmissions
- **H1**: Describe Power Transmission Theory (3)
- **H2**: Service Couplings (3)
- **H3**: Service Gear Drives (3)
- **H4**: Service Belt Drives (3)
- **H5**: Service Clutches and Brakes (3)
- **H6**: Service Chain Drives (3)
- **H7**: Service Drive Shafts (2)

## Service Fluid Power
- **I1**: Explain Hydraulic Theory (2)
- **I2**: Interpret Hydraulic Schematics (2)
- **I3**: Describe Hydraulic Components (2)
- **I4**: Identify Hydraulic Pumps (2)
- **I5**: Describe, Assemble and Maintain Hydraulic Circuits (3)
- **I6**: Explain Pneumatic Theory (4)
- **I7**: Describe Pneumatic Components (4)
- **I8**: Interpret Pneumatic Schematics (4)
- **I9**: Identify Pneumatic Pumps (4)
- **I10**: Assemble, Maintain and Troubleshoot Pneumatic Circuits (4)
- **I11**: Explain the Theory of Vacuum and Vacuum Systems (4)
- **I12**: Interpret Vacuum Symbols (4)
- **I13**: Identify Vacuum System Components (4)
- **I14**: Describe Vacuum Systems (4)
- **I15**: Maintain and Troubleshoot Vacuum Systems (4)

## Service Compressors
- **J1**: Explain Compressor Theory (4)
- **J2**: Identify and Describe Types of Compressors (4)
- **J3**: Service Compressors (4)

*W = Workplace Skill Acquisition*
### Program Overview

<table>
<thead>
<tr>
<th>SERVICE PUMPS</th>
<th>Explain Pump Theory</th>
<th>Identify Types of Pumps</th>
<th>Install, Maintain and Troubleshoot Positive Displacement Pumps</th>
<th>Install, Maintain and Troubleshoot Non-Positive Displacement Pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td></td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>K1</td>
<td>K2</td>
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</table>

<table>
<thead>
<tr>
<th>SERVICE MATERIAL HANDLING SYSTEMS</th>
<th>Explain Material Handling Theory</th>
<th>Maintain Fans and Blowers</th>
<th>Identify Types of Conveyors</th>
<th>Describe Methods of Conveyor Loading and Unloading, and Types of Process Tanks and Storage Containers</th>
<th>Maintain Conveyor Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>L1</td>
<td>L2</td>
<td>L3</td>
<td>L4</td>
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<td>3</td>
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</table>

<table>
<thead>
<tr>
<th>OPERATIONAL EQUIPMENT EFFECTIVENESS</th>
<th>Describe Operational Equipment Effectiveness Processes</th>
<th>Describe Use of Predictive Maintenance Tools</th>
<th>Identify Equipment and Process Deficiencies</th>
<th>Perform Vibration Analysis and Rotating Equipment Balancing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M1</td>
<td>M2</td>
<td>M3</td>
<td>M4</td>
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<td>4</td>
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</tbody>
</table>

W = Workplace Skill Acquisition
## Program Overview

### Training Topics and Suggested Time Allocation

#### MILLWRIGHT – LEVEL 1

<table>
<thead>
<tr>
<th>Line</th>
<th>WORK PRACTICES</th>
<th>% of Time Allocated to:</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tr>
<td>A1</td>
<td>Explain Federal/Provincial Occupational Health and Safety Regulations</td>
<td>23%</td>
<td>75%</td>
<td>25%</td>
<td>100%</td>
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<tr>
<td>A2</td>
<td>Explain and Apply Environmental Regulations</td>
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</tr>
<tr>
<td>A3</td>
<td>Use Personal Protective Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Follow Safe Working Practices</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A5</td>
<td>Use Communication and Teamwork Skills</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>A6</td>
<td>Interpret Plans and Sketches</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>A7</td>
<td>Use Reference Resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>Use Trade Math</td>
<td>25%</td>
<td>75%</td>
<td>25%</td>
<td>100%</td>
</tr>
<tr>
<td>B3</td>
<td>Describe Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B6</td>
<td>Use Fasteners</td>
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</tr>
<tr>
<td>C1</td>
<td>Use Hand Tools</td>
<td>34%</td>
<td>20%</td>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>C2</td>
<td>Use Measuring and Layout Tools and Instruments</td>
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<tr>
<td>C3</td>
<td>Use Portable Power Tools</td>
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<td>C4</td>
<td>Use Fixed Shop Machines and Equipment</td>
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</tr>
<tr>
<td>C5</td>
<td>Use Mobile Access Equipment</td>
<td></td>
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</tr>
<tr>
<td>F1</td>
<td>Describe Welding Practices</td>
<td>18%</td>
<td>10%</td>
<td>90%</td>
<td>100%</td>
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<tr>
<td>F2</td>
<td>Use and Maintain Oxy-Fuel Cutting, Welding, and Heating Equipment</td>
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<tr>
<td>F3</td>
<td>Use and Maintain Shielded Metal Arc Welding (SMAW) Equipment</td>
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</tr>
<tr>
<td>F4</td>
<td>Use and Maintain Plasma Arc Cutting Equipment</td>
<td></td>
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</tbody>
</table>

**Total Percentage for Millwright Level 1** 100%
## Program Overview

### Training Topics and Suggested Time Allocation

**MILLWRIGHT – LEVEL 2**

<table>
<thead>
<tr>
<th>Line</th>
<th>Section</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tbody>
<tr>
<td>Line B</td>
<td>TRADE SCIENCE</td>
<td>25%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>B2</td>
<td>Use Trade Science</td>
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<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>Explain Simple Machines</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td>Use Fits and Tolerances</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line D</td>
<td>LUBRICANTS, SEALS AND BEARINGS</td>
<td>20%</td>
<td>60%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>D1</td>
<td>Select Lubricants</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>Maintain Lubricating Systems</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>Select Seals, Gaskets and Packing</td>
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<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>Install and Maintain Seals</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>Select Bearings</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>Install and Maintain Bearings</td>
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<td></td>
</tr>
<tr>
<td>Line E</td>
<td>INSTALL EQUIPMENT</td>
<td>20%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
</tr>
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# Program Overview

## Training Topics and Suggested Time Allocation

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**Total Percentage for Millwright Level 3**: 100%
### Training Topics and Suggested Time Allocation

#### MILLWRIGHT – LEVEL 4

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## Program Overview

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| Total Percentage for Millwright Level 4 | 100% |
Section 3

PROGRAM CONTENT

Millwright
Level 1
Millwright
Line (GAC): A WORK PRACTICES
Competency: A1 Explain Federal/Provincial Occupational Health and Safety Regulations

Objectives
To be competent in this area, the individual must be able to:

- Describe the application of the parts of the Workers’ Compensation Act outlined in the Occupational Health and Safety Regulations.
- Describe the application of the Occupational Health and Safety Regulations and know how to find requirements applicable to the millwright workplace.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Define terms used in Federal-Provincial Occupational Health and Safety Regulations | - Workers Compensation Act
- Industrial Health and Safety Regulations
- Federal Regulations
- Other Federal jurisdictions
- British Columbia Mines Act
- WHMIS (Workplace Hazardous Materials Information System) |

2. Describe the Occupational Health and Safety Regulations | - Housekeeping
- Confined Space
- Material Storage
- Ladders/Scaffolding
- Fall Arrest
- WHMIS
- Lockout/Tagout procedures
- Ventilation requirements |
Line (GAC): A WORK PRACTICES
Competency: A2 Explain and Apply Environmental Regulations

Objectives
To be competent in this area, the individual must be able to:

- Describe the purpose of HAZMAT (Hazardous Materials Safety) regulations and the WHMIS regulations.
- Explain the contents and employee responsibility regarding HAZMAT regulations and the WHMIS regulations.
- Interpret material information sheets (MSDS (Material safety data sheets) and HAZMAT).
- Apply knowledge of WHMIS and HAZMAT regulations to maintain a safe working environment.

LEARNING TASKS

1. Describe HAZMAT regulations for the transportation of hazardous materials
   - Signage
   - Reporting incidents
   - Safe handling and cleanup procedures
   - Transporting

2. State the legislation that requires suppliers of hazardous materials to provide MSDSs and label products as a condition of sale and importation
   - Hazardous Product Act
   - Controlled Products Regulations
   - Ingredient Disclosure List
   - Hazardous Materials Information Review Act
   - Hazardous Materials Information Review Regulations

3. State the work purpose of the Workplace Hazardous Materials Information System (WHMIS)
   - Protection of workers from adverse effects of hazardous materials through provision of relevant information while minimizing economic impact on industry and disruption of trade
   - Recognition of rights
     - Workers
     - Employers
     - Suppliers
     - Regulators

4. Describe the key elements of WHMIS
   - Material safety data sheets (MSDS)
   - Labelling of containers of hazardous materials
   - Worker education programs

5. Describe the responsibilities of suppliers under WHMIS
   - Provide
     - MSDSs
     - Labels

6. Describe the responsibilities of employers under WHMIS
   - Provide
     - MSDSs
     - Labels
     - Work education programs in the workplace
7. Describe information to be disclosed on a MSDS

- Hazardous ingredients
- Preparation information
- Product information
- Physical data
- Fire or explosion
- Reactivity data
- Toxicological properties
- Preventive measures
- First-aid measures

8. Identify symbols found on WHMIS labels and their meaning

- Compressed gases
- Flammable and combustible materials
- Oxidizing materials
- Poisonous and infectious materials
  - Materials causing immediate and serious toxic effects
  - Materials causing other toxic effects
  - Bio-hazardous infectious materials
  - Corrosive materials
  - Dangerously reactive materials

9. Explain how WHMIS applies to hazardous materials used in the shop

- Use, storage and disposal of
  - Solvents
  - Caustic cleaners
  - Cleaning solutions

10. Maintain safe working area

- Demonstrate an understanding of HAZMAT and WHMIS regulations
Line (GAC): A WORK PRACTICES
Competency: A3 Use Personal Protective Equipment

Objectives
To be competent in this area, the individual must be able to:

- Identify the personal protective equipment required for various situations.
- Use personal protective equipment and explain proper maintenance and storage techniques.

LEARNING TASKS

1. Identify personal safety equipment
   - Respirators
   - Eye protection / Face shield
   - Eye-wash stations
   - Hearing protection
   - Hand protection
   - Head protection
   - Foot protection
   - Clothing (safety vest, coveralls)
   - Fall arrest

2. Use personal safety equipment
   - Respirators
   - Eye protection / Face shield
   - Eye-wash stations
   - Hearing protection
   - Hand protection
   - Head protection
   - Foot protection
   - Clothing (safety vest, coveralls)

3. Explain the proper maintenance and storage of personal safety equipment
   - Respirators
   - Eye protection / Face shield
   - Eye-wash stations
   - Hearing protection
   - Head protection
   - Clothing (safety vest, coveralls)
   - Fall arrest
LINE (GAC): A WORK PRACTICES
Competency: A4 Follow Safe Working Practices

Objectives
To be competent in this area, the individual must be able to:

- Identify various possible hazards that may be encountered on the job site and describe the corrective actions required.
- Explain lockout / tagout requirements and lockout / tagout procedures for various situations.
- Identify fire hazards and the four types of fires.
- Explain the principles of fire fighting and describe the safe use of fire fighting equipment.
- Recognize the ergonomic risks in the workplace and identify applicable preventive measures.

LEARNING TASKS

1. Identify job site hazards
   - Tripping hazards
   - Overhead work
   - Excavations
   - Inadequate lighting
   - Electrical hazards
   - Noise hazards
   - Moving equipment and loads
   - Improper storage
   - Housekeeping
   - Stored energy sources
   - Confined areas
     - Rotating equipment hazards
     - Loose cabling and straps
   - Identify fire hazards
     - Welding hazards
     - Chemical hazards
     - Electrical hazards
     - Improper disposal of combustible / flammable materials

2. Explain lockout / tagout and de-energization requirements for various sources of energy
   - Hazardous energy
   - Electrical
   - Hydraulic
   - Steam
   - Pneumatic / vacuum
   - Interlock systems

3. Identify lockout / tagout and de-energization procedures
   - Use of locks
   - Tags
   - Cables
   - Key-box system
LEARNING TASKS

4. Describe proper use of guards and guarding for various situations

5. Describe the use of work platforms

6. Describe the use of work permits

7. Identify various types of fires

8. Explain principles of fire fighting

9. Describe the proper use of fire extinguishers

10. Describe the considerations and steps to be taken prior to fighting a fire

CONTENT

- Blocking and bleeding systems
- Styles of guards
- Interlock guards
- Elevated platforms
- Guard rails
- Stairs
- Toe-boards
- Various applicable regulations
- Equipment release for maintenance
- Overlapping safety considerations
- Type A
- Type B
- Type C
- Type D
- Fire triangle
- Flammable liquids
- Loose material
- Gas
- Company specific firefighting procedures
- Handling and usage (PASS)
- Pull
- Aim
- Squeeze
- Sweep
- Storage
- Inspection
  - Signed
  - Dated
  - Sealed
- Identification
  - Colour
  - Shape
  - Lettering
- Warning others and notifying fire department
- Evacuation of others
- Fire contained and not spreading
- Personal method of egress
- Training
LEARNING TASKS

11. Identify lifting risks and considerations

12. Demonstrate safe lifting techniques

13. Identify the risks of repetitive motion

CONTENT

- Lifting techniques
- Limitations
- Personal safety equipment
- Hands
- Arms
- Back
- Repetitive motion
  - Hand
  - Arm
  - Back
Line (GAC): A WORK PRACTICES
Competency: A5 Use Communication and Teamwork Skills

Objectives
To be competent in this area, the individual must be able to:
- Use trade terminology in clear oral and written communication.
- Identify and use paper-based and electronic record keeping systems.

**LEARNING TASKS**

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<td>Maintain records specific to workplace requirements</td>
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**Achievement Criteria**

Performance The learner will be evaluated on the ability to:
- Maintain records specific to workplace requirements

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): A WORK PRACTICES
Competency: A6 Interpret Plans and Sketches

Objectives
To be competent in this area, the individual must be able to:

- Identify the types of drawings and diagrams associated with the millwright trade.
- Identify the elements common to all drawings, plans and sketches.
- Produce a sketch using common drawing elements.
- Interpret industrial drawings which apply to and are related to the installation and maintenance of equipment.

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<td>4. Interpret industrial drawings</td>
<td>Mechanical, Installation, Piping, Structural, Electrical</td>
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<td>5. Produce a sketch</td>
<td>Produce a sketch using criteria in learning tasks 1, 2 and 3</td>
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</table>
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  •  Produce a sketch using common drawing elements.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
# Line (GAC): A WORK PRACTICES

## Competency: A7 Use Reference Resources

### Objectives

To be competent in this area, the individual must be able to:

- Read and interpret various textbooks, service manuals and bulletins related to the performance of the work.
- Locate information from a variety of sources necessary to maintain, troubleshoot and service equipment.

### LEARNING TASKS

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<td>• API</td>
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</table>
Achievement Criteria

**Performance**  The learner will be evaluated on the ability to:

- Locate information from a variety of resources necessary to maintain, troubleshoot and service equipment.

**Conditions**  As part of practical lab tasks, given the required tools and materials

**Criteria**  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): B TRADE SCIENCE
Competency: B1 Use Trade Math

Objectives
To be competent in this area, the individual must be able to:

- Use a scientific calculator, graphs, tables and charts to solve problems in their work place.
- Apply the correct mathematical calculations required to perform their duties.

LEARNING TASKS CONTENT

1. Use a scientific calculator
   - Hierarchy
   - Functions
   - Usage

2. Solve problems using whole numbers
   - Odd and even numbers
   - Negative and positive numbers
   - Prime numbers
   - Perform mathematical calculations
     - Addition
     - Subtraction
     - Multiplication
     - Division

3. Solve problems using common fractions
   - Terminology
     - Fraction
     - Numerator
     - Denominator
     - Proper fraction
     - Improper fraction
     - Mixed numbers
     - Lowest term lowest denominator
     - Complex fractions
   - Perform mathematical calculations
     - Addition
     - Subtraction
     - Multiplication
     - Division

4. Solve problems using decimal fractions
   - Terminology
     - Decimal system
     - Decimal point
     - Decimal fraction
     - Place value
     - Rounding off
     - Repeating decimal
     - Significant digit
LEARNING TASKS

5. Solve problems using ratio proportion

6. Solve problems with percentages

7. Solve problems dealing with perimeters and circumference

8. Solve problems dealing with areas and volumes

9. Solve problems using algebra

CONTENT

• Perform mathematical calculations
  o Addition
  o Subtraction
  o Multiplication
  o Division

• Terminology
  o Ratio
  o Terms
  o Proportion
  o Cross multiplication
  o Inverse ratio
  o Inverse proportion

• Perform calculations using ratios

• Perform calculations using proportions
  o Proper proportions
  o Inverse proportions

• Terminology
  o Common fraction
  o Decimal fraction

• Perform calculations using percentages

• Concept of perimeters

• Geometric shapes
  o Squares
  o Triangles
  o Rectangles
  o Arcs
  o Circles/ellipse

• Concept of area

• Geometric shapes
  o Squares
  o Triangles
  o Rectangles
  o Arcs
  o Circles/ellipse

• Concept of volume

• Terminology

• Transpose formulas

• Transpose equations

• Perform calculations using algebra functions
LEARNING TASKS

10. Solve problems using metric and imperial units

CONTENT

• Terminology
  o Length, area and volume
  o Weight
  o Temperature

• Convert between metric and imperial units
• Perform calculations using metric and imperial units

Achievement Criteria

Performance The learner will be evaluated on the ability to:
• Use a scientific calculator, graphs, tables and charts to solve problems
• Apply the correct mathematical calculations required solve problem.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC):  B  TRADE SCIENCE
Competency:  B3  Describe Materials

Objectives
To be competent in this area, the individual must be able to:

- Identify the characteristics associated with metals and list methods of mechanical and chemical testing.
- Describe types of metals and their properties.
- Describe the metallurgical principles of ferrous and non ferrous metals, using appropriate trade terminology.
- Use heat treatment tools and equipment

LEARNING TASKS
1. Identify common metals

CONTENT

- Define terms
  - Ductility
  - Malleability
  - Toughness
  - Brittleness
- Methods of identification
  - Non-destructive testing techniques
    - Dye penetration
    - UV lights
  - Mechanical testing
    - Spark
    - File
    - Chisel
    - Hardness
    - Impact
    - Ultrasonic thickness
  - Chemical testing
    - Acid
    - Caustic
- Manufacturing process of iron and steel
  - Smelting
  - Refining
- Methods and manufacture
  - Forging
  - Casting
  - Rolling
LEARNING TASKS

2. Identify properties of metals

   - Tension
   - Compression
   - Torsion
   - Bending
   - Shearing
   - Safe load
   - Elastic limit
   - Yield point
   - Failure point

3. Describe the metallurgical principles of ferrous metals

   - Terminology
     - Heat treatment
     - Upper critical temperature
     - Lower critical temperature
     - Critical range
     - Hardening
     - Case hardening
     - Tempering
     - Annealing
     - Normalizing
     - Perlite
     - Ferrite
     - Cementite
     - Austenite
     - Martensite
   - Methods of hardening and tempering steels
     - Prepare metals for hardening and tempering
     - Heat and molecular changes
     - Oxidation
   - Causes of failure
     - Fatigue
     - Oxidation
     - Stress cracking
     - Corrosion
     - Brittleness

4. Describe the metallurgical properties of non-ferrous metals

   - Aluminum
   - Copper
   - Brass
   - Bronze
   - Stainless steel
   - Chrome alloys
   - Manganese
   - Titanium
LEARNING TASKS

5. Describe the use and properties of non-metallic materials

6. Perform heat treatment of metal

CONTENT

- Rubber
- Plastics
- Epoxy resins
- Safe use of ovens and forges
- Contaminant removal
- De-scale

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Use heat treatment tools and equipment
- Perform heat treatment of metal

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
LINE (GAC): B TRADE SCIENCE
Competency: B6 Use Fasteners

Objectives
To be competent in this area, the individual must be able to:

- Classify and identify mechanical fasteners and locking devices.
- Identify and use appropriate tools and describe methods required to set torque values.
- Explain and use methods to determine the strength of fastening devices.
- Identify and use the proper chemical fastening compound for various situations.

LEARNING TASKS

1. Identify methods of classifying mechanical fasteners
   - Organizations setting standards
     - ANSI (American National Standards Institute)
     - SAE (Society of Automotive Engineers)
     - ISO (International Organization for Standardization)
     - SI (Standards International)
     - CSA (Canadian Standards Association)
     - ASTM (American Society for Testing and Materials)
   - Grade markings
     - Metric
     - Imperial
   - Thread forms
     - ANC (American National)
     - UN (Unified National)
     - Metric
     - Whitworth
     - Buttress
     - Square
     - Acme
   - Fastener dimensions
     - Head size
     - Shank size
     - Length

2. Identify, select and use fasteners and locking devices
   - Bolts
   - Screws
   - Studs
   - Retaining rings
   - Retaining pins
   - Rivets
   - Measurement of threads
LEARNING TASKS

3. Identify and use tools required for installation
   - Wrenches
   - Slug wrenches
   - Hydraulic wrenches
   - Impact wrenches
   - Snap-ring pliers
   - Riveting devices

4. Describe methods and set torque values
   - Torque wrenches
   - Hydraulic wrenches
   - Stretch method
   - Refer to service manuals

5. Describe methods used to calculate strengths of fasteners
   - Tensile and shear strength of
     - Bolts
     - Screws
     - Rivets

6. Apply methods of cutting threads and thread recovery
   - Identify the various tools in cutting threads
     - Taps
     - Dies
     - Thread gauges
     - Threading machines
     - Lathes
   - Identify methods of repairing damaged threads
     - Thread chasers
     - Thread files
     - Helicoil
     - Other method

7. Select and use epoxies and resins
   - Drying time
   - Material compatibility
   - Resistance to water, oil and other substances
   - Bonding strength and resistance to impact and tension
   - Select to meet various applications
   - Use according to specifications
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Select and use fasteners and locking devices
  • Select and use tools for installation
  • Select and use tools to set torque values
  • Select and use tools to cut threads and perform thread recovery
  • Select and use epoxies and resins

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): C USE TOOLS
Competency: C1 Use Hand Tools

Objectives
To be competent in this area, the individual must be able to:

- Select and use millwright’s hand tools.
- Clean and maintain millwright’s hand tools.

LEARNING TASKS

1. Select and use hand tool

CONTENT

- General
  - Safe use for intended purpose
  - Proximity to other people
  - Personal protective equipment

- Striking tools
  - Hammers
  - Mallets
  - Sledges

- Wrenches / sockets
  - Open-end
  - Box-end
  - Combination
  - Slug
  - Pipe wrenches
  - Chain
  - Strap wrenches
  - Allen wrenches
  - Miscellaneous

- Screwdrivers
  - Slot
  - Robertson
  - Phillips
  - Torx

- Cutting tools
  - Hack saws
  - Hand saw
  - Chisels
  - Taps and dies
  - Reamers
  - Broaches
  - Scrapers
  - Files
  - Snips and shears

- Clamping devices
  - Pliers
  - Clamping pliers
  - Various types of clamps
  - Vices
LEARNING TASKS

2. Maintain hand tools

CONTENT

- Pullers
  - Two and three jaw
  - Slide hammer
  - Guillotine
  - Miscellaneous pullers

- Miscellaneous/specialty tools
  - Stud extractors

- Miscellaneous/specialty tools

Achievement Criteria

Performance
The learner will be evaluated on the ability to:

- Select and use millwright’s hand tools.
- Maintain millwright’s hand tools.

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
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Level 1

Line (GAC): C USE TOOLS
Competency: C2 Use Measuring and Layout Tools and Instruments

Objectives
To be competent in this area, the individual must be able to:

- Identify and use measuring tools and instruments.
- Describe maintenance and storage procedures for measuring tools and instruments.
- Identify and use layout tools and instruments.
- Describe maintenance and storage procedures for layout tools and instruments.

LEARNING TASKS

1. Identify measuring tools and describe their purpose and limitations
   - Comparison and transfer measuring tools
     - Inside callipers
     - Outside callipers
     - Feeler gauges
     - Straight edges
     - Hole gauges
     - Angle gauges
     - Protractors
     - Squares
     - Gauge blocks
     - Telescoping gauges
     - Taper gauges
   - Direct/precision measuring tools
     - Inside micrometers
     - Outside micrometers
     - Depth micrometers
     - Miscellaneous micrometers
     - Vernier callipers
     - Vernier height gauge
     - Steel scales
     - Dial indicators

2. Adjust and use measuring tools
   - Checking for accuracy with a standard
   - Adjusting and setting
   - Measure various components for
     - Diameter
     - Concentricity
     - Parallelism
     - Depth
     - Size

3. Describe maintenance and storage procedures for measuring tools
   - Maintenance
   - Storage
LEARNING TASKS

4. Identify layout tools and describe their purpose

CONTENT

- Layout solutions
- Surface plates/layout tables
- Sine bar and gauge blocks
- Scribers
- Trammels
- Dividers
- Hermaphrodite callipers
- Squares
- Combination sets
- Surface gauge
- Prick punches
- Center punches
- Parallels
- V-blocks
- Angle plates
- Vernier height gauge
- Transits
- Theodolite
- Rotary laser level
- Builder’s level (dumpy level)

5. Adjust and use layout tools

- Checking for accuracy
- Layout tools to construct and transfer geometric shapes
  - Perpendicular lines
  - Bisect lines
  - Divide lines into equal parts
  - Angles
  - Bisect angles
  - Transfer angles
  - Circles
  - Circles within circles
  - Locate centre of circles
  - Hexagons
  - Octagons
- Triangles

6. Describe maintenance and storage procedures for layout tools

- Maintenance
- Storage
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Adjust and use measuring tools and instruments
  • Adjust and use layout tools and instruments.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Objectives
To be competent in this area, the individual must be able to:

- Select and safely use portable power tools.
- Maintain and repair portable power tools.

LEARNING TASKS

1. Describe types of power hand tools
   - Methods of operation
     - Air
     - Hydraulic
     - Electrical
     - Powder actuated
   - Types of tools
     - Drilling
     - Impact
     - Cutting
     - Grinding
     - Powder actuated
     - Portable milling machines
     - Magnetic base drill

2. Use and maintain power hand tools
   - Safe work practices
   - Types of tools
     - Drilling
     - Impact
     - Cutting
     - Grinding
     - Powder actuated
     - Portable milling machines
   - Care and maintenance of tools

Achievement Criteria

Performance
The learner will be evaluated on the ability to:
- Use power hand tools.
- Maintain power hand tools.

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Objectives
To be competent in this area, the individual must be able to:

- Select and safely use fixed shop machines and equipment.
- Maintain and repair fixed shop machines and equipment.

LEARNING TASKS

1. Describe various stationary power tools
   - Lathes
   - Milling machines
   - Grinders
   - Drill presses
   - Saws
   - Cut-off tools
   - Threading machines
   - Presses

2. Explain safe use of stationary power tools
   - WCB regulations
   - Machine shop safety
   - Personal safety
   - Intrinsically safe tools

3. Set up and use stationary power tools
   - Alignment checks
   - Set up of work pieces
   - Speeds and feeds
   - Cutting fluids
   - Basic operations
   - Use of attachments
   - Use of cutting tools
     - Types
     - Feed rates
     - Speeds

4. Maintain and repair stationary power tools
   - Proper care and upkeep
   - Inspect machines for defects
   - Maintain machines in safe working condition
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Setup and use stationary power tools.
  • Maintain and repair stationary power tools.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): C USE TOOLS
Competency: C5 Use Mobile Access Equipment

Objectives
To be competent in this area, the individual must be able to:

- Identify and describe the use of mobile access equipment.
- Perform routine inspection of mobile access equipment.
- Use ladders and scaffolding.

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• Scissor lifts  
• Basket lifts |
| 2. Describe the use of mobile access equipment | • WCB regulations  
  o Pre-use inspections  
• Forklifts  
  o Employer certification and proof of competency requirements  
• Scissor lifts  
• Basket lifts |
| 3. Describe mobile access equipment inspection | • Forklifts  
• Scissor lifts  
• Basket lifts  
• Maintenance records |
| 4. Select and use ladders | • Applicable WCB regulations  
• Types of ladders and construction  
• Safe use  
• Maintenance  
• Storage |
| 5. Select and use scaffolding | • Applicable WCB regulations  
• Safe use  
• Types of scaffolding  
• Assembly and disassembly  
• Attachments and fittings  
• Maintenance  
• Storage |
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Perform routine inspection of mobile access equipment.
  • Use ladders and scaffolding.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): F CUT, FIT AND FABRICATE
Competency F1 Describe Welding Practices

Objectives
To be competent in this area, the individual must be able to:

- Describe the safe work practices for oxy-acetylene or gas heating, welding and cutting.
- Describe the safe work practices for electric arc welding and cutting.

LEARNING TASKS

1. Describe safe work practices for oxy-acetylene heating, cutting and welding
   - Inspect area for fire hazards
   - Applicable safety regulations
   - Safety equipment
   - Applicable fire watch
     - Use of proper fire extinguishers
     - Length of time spotter is required
   - Proper ventilation
   - Confined space requirements
   - Identify unsafe equipment

2. Describe safe work practices for electric arc welding
   - Inspect area for fire hazards
   - Applicable safety regulations
   - Safety equipment
   - Applicable fire watch
     - Use of proper fire extinguishers
     - Length of time spotter is required
   - Proper ventilation
   - Confined space requirements
   - Identify unsafe equipment

3. Describe methods and safe work practices for equipment heating
   - Gas types and pressure
     - Propylene (tm)
     - Propane
     - Acetylene
     - Oxygen
     - Natural gas
   - Electric
Line (GAC): F CUT, FIT AND FABRICATE

Competency: F2 Use and Maintain Oxy-Fuel Cutting, Welding and Heating Equipment

Objectives
To be competent in this area, the individual must be able to:

- Set up and regulate gas welding equipment.
- Perform gas welding and cutting.
- Maintain gas welding equipment

LEARNING TASKS

1. Describe oxy-acetylene equipment
   - Safety precautions
   - Gas types and pressures
   - Handling and storage of gas cylinders
   - Types of equipment
     - Regulators
     - Torches
     - Hoses
     - Cylinders
     - Safety devices

2. Use oxy-acetylene equipment
   - Setup Procedures
     - Regulators
     - Torches
     - Hoses
     - Cylinders
     - Safety devices
   - Cutting
     - Identify material being cut
       - Plate
       - Sheet
       - Round stock
       - Re-bar
       - Miscellaneous shapes
       - Nuts off bolts
   - Cutting applications
     - Holes
     - Bevels
     - Angles
     - Freehand and guided cuts
   - Describe welding and brazing
     - Fusion welding
     - Brazing
       - Matching material and rod
       - Torch speed
     - Fluxes
## Program Content

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<tr>
<td>o  Propylene</td>
<td>•  Heating</td>
</tr>
</tbody>
</table>

### Achievement Criteria

**Performance**  The learner will be evaluated on the ability to:

- Setup and use oxy-acetylene equipment
- Perform gas welding and cutting.
- Maintain gas welding equipment.

**Conditions**  As part of practical lab tasks, given the required tools and materials

**Criteria**  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): F  CUT, FIT AND FABRICATE
Competency:  F3 Use and Maintain Shielded Metal Arc Welding (SMAW) Equipment

Objectives
To be competent in this area, the individual must be able to:

- Identify shielded metal arc welding (SMAW) equipment.
- Perform shielded metal arc welding.
- Maintain shielded metal arc welding equipment.

LEARNING TASKS

1. Explain the principles of electricity and its application to shielded metal arc welding
   - Basic principles of electricity
   - Types of current and their applications
   - Describe AC/DC welding

2. Describe shielded metal arc welding equipment
   - Associated equipment
     - Electrode holders
     - Ground clamps
     - Cables
   - Electrodes
     - Common SMAW electrodes
     - Correct handling and storage
     - Select for specific application

3. Perform shielded metal arc welding
   - Set up
   - Amperage adjustment
   - Polarity selection
   - Basic joint design
   - Weld types, sizes and profiles
   - Welding positions
     - Flat
     - Horizontal
   - Weld faults
     - Undercuts
     - Porosity
     - Inclusions
     - Voids
   - Methods of distortion control
   - Maintenance procedures
     - Stinger
     - Cables
     - Clamps
     - Plugs
     - Safety devices
   - Shut down
Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Perform shielded metal arc welding.
- Maintain shielded metal arc welding equipment.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 1

Line (GAC): F CUT, FIT AND FABRICATE
Competency: F4 Use and Maintain Plasma Arc Cutting Equipment

Objectives
To be competent in this area, the individual must be able to:

- Safely cut using plasma arc cutting equipment.
- Setup plasma arc cutting equipment.
- Use and maintain plasma arc cutting equipment.

LEARNING TASKS

1. Describe plasma arc cutting equipment
   - Safety precautions
   - Gas types and pressures
   - Grounding requirements

2. Use plasma arc cutting equipment
   - Setup
   - Application
   - Cutting procedures
   - Identification of unsafe equipment
   - Maintenance procedures
     - Regulators
     - Torch head and components
     - Hoses
     - Safety devices

Achievement Criteria

Performance  The learner will be evaluated on the ability to:
   - Setup and use plasma arc cutting equipment.
   - Maintain plasma arc cutting equipment.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Level 2
Millwright
Program Content
Level 2

Line (GAC): B TRADE SCIENCE
Competency: B2 Use Trade Science

Objectives
To be competent in this area, the individual must be able to:

- Use a scientific calculator, graphs, tables and charts to solve problems in the work place.
- Apply the correct mathematical calculations required to perform workplace duties.

LEARNING TASKS CONTENT

1. Review math calculations
   - Whole numbers
   - Common fractions
   - Decimal fractions
   - Ratio and proportions
   - Percentages
   - Perimeter
   - Area
   - Concept of volume
   - Algebra
   - Metric and imperial
     - Calculations
     - Conversions

2. Solve problems dealing with solids
   - Geometric shapes
     - Prisms
     - Cones
     - Pyramids
     - Spheres
   - Lateral surface area
     - Prisms
     - Cones
     - Pyramids

3. Solve problems using trigonometry
   - Relationship of functions
     - Sine
     - Cosine
     - Tangent
   - Solve problems using trigonometry
     - Sine
     - Cosine
     - Tangent
LEARNING TASKS

4. Use graphs to solve problems

5. Describe the properties and calculate the strength of materials

6. Calculate work and power

CONTENT

- Terminology
  - Charts
  - Tables
  - Graphs
- Interpret graphs, charts and tables
- Terminology
  - Tensile strength
  - Shear strength
  - Compressive strength
  - Bearing load
- Calculate strengths
- Non-destructive testing (NDT) techniques
- Identify hoisting/lifting equipment to detect underlying defects such as cracks

- Terminology
  - Work
  - Power
  - Horsepower
  - Brake horsepower
- Convert between metric and imperial units
- Perform calculations involving
  - Work
  - Power
  - Horsepower
  - Brake horsepower

Achievement Criteria

Performance
The learner will be evaluated on the ability to:
- Solve problems dealing with solids
- Use trigonometry to solve problems
- Use graphs to solve problems
- Calculate work and power

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): B TRADE SCIENCE
Competency: B4 Explain Simple Machines

Objectives
To be competent in this area, the individual must be able to:

- Explain the use of simple machines in the workplace.
- Describe problems associated with simple and compound machines.

LEARNING TASKS

1. Identify simple machines

2. Describe problems involving forces associated with simple machines

CONTENT

- Classes of levers
- Wheels and axles
- Pulleys
- Inclined planes
- Screw jacks
- Compound machines
- Turning moments
- Mechanical advantage
- Distributed loads
- Acceleration
- Velocity
Objectives
To be competent in this area, the individual must be able to:

- Identify and describe tolerances, fits and fitting methods.
- Describe and apply fitting techniques and procedures associated with the assembly of equipment.

**LEARNING TASKS**

1. Identify and describe tolerances
   - Bilateral
   - Unilateral
   - Basic hole system
   - Basic shaft system

2. Identify and describe fits
   - Locational
   - Interference
   - Clearance
   - Transition
   - Running

3. Apply methods of fitting
   - Expansion
   - Shrink
   - Force

4. Explain procedures and perform fitting
   - Check for run-out
   - Concentricity
   - Parallelism
   - Angularity

**Achievement Criteria**

Performance The learner will be evaluated on the ability to:
- Apply methods of fitting
- Perform fitting procedures

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): D LUBRICANTS, SEALS AND BEARINGS
Competency: D1 Select Lubricants

Objectives
To be competent in this area, the individual must be able to:

- Describe the properties and characteristics of lubricants.
- Select the correct lubricant for specific applications.
- Describe the safe use, storage and handling of lubricants.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe types of friction | Types of friction
  - Rolling
  - Sliding
  - Fluid
  - Starting
- Causes of friction
- Effects of friction |
| 2. Describe oil lubrication | Oil wedge
  - Boundary
  - Full film |
| 3. Describe types and properties of lubricants | Types of lubricants
  - Grease
  - Oil
  - Synthetic oils
- Properties and characteristics of grease
  - Additives
  - Soap
  - Non-soap
  - Multi-grease
    - Multi-purpose grease
    - Extreme pressure grease
  - Mixed soap
  - Grades
  - Polar attraction
  - Directional fluidity
  - Selection process
  - Compatibility
- Properties and characteristics of oil
  - Viscosity
    - Kinematics
    - Dynamic
    - Index
  - Grading systems
  - Additives
  - Inhibitors |
LEARNING TASKS

4. Select lubricants for specific purposes

5. Describe handling procedures

CONTENT

- Classifications
- Oil wedge principle
  - Oil
    - Advantages
    - Disadvantages
  - Grease
    - Advantages
    - Disadvantages
- Safe handling
- WHMIS
- Storage
## Line (GAC): D LUBRICANTS, SEALS AND BEARINGS

**Competency:** D2 Maintain Lubricating Systems

### Objectives
To be competent in this area, the individual must be able to:

- Identify types of lubricating systems.
- Maintain and service lubricating systems.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe various lubrication systems | • Automatic  
 • Pressure  
 • Gravity  
 • Reservoir  
 • Splash  
 • Flinger  
 • Manual  
 • Capillary  
 • Injector |
| 2. Maintain lubrication systems | • Inspection procedures  
 • Diagnosing lubricant problems  
   - Visual  
   - Smell  
   - Feel  
   - Chemical analysis  
 • Tribology  
 • Cleaning system  
 • Disposing of old lubricant |

### Achievement Criteria

**Performance** The learner will be evaluated on the ability to:

- Maintain and service lubricating systems.

**Conditions** As part of practical lab tasks, given the required tools and materials

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
## Program Content

**Level 2**

Line (GAC): D  LUBRICANTS, SEALS AND BEARINGS

Competency: D3  Select Seals, Gaskets and Packing

### Objectives

To be competent in this area, the individual must be able to:

- Select the correct seals, packing and gaskets to meet specific applications.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe classes of sealing | - External sealing  
  o Positive  
  o Non-positive  
  o Static  
  o Dynamic  
  - Internal sealing  
  o Positive  
  o Non-positive  
  o Static  
  o Dynamic |
| 2. Identify and describe gaskets | - Types of joints  
  o Unconfined  
  o Confined  
  o Partially confined  
  o Self confined  
  o Self energized  
  - Describe gaskets  
  o Sealing  
  o Materials  
  o Installation  
  o Stamping (size) |
| 3. Identify and describe packing | - Types of packing  
  o O-rings  
  o V-packing  
  o U-section packing  
  o Cup packing  
  o Jam packing  
  o Compression packing |
| 4. Identify and describe mechanical seals | - Types  
  o Balanced  
  o Un-balanced  
  o Internal  
  o External  
  o Tandem  
  o Duplex  
  - Materials  
  o Metallic  
  o Non-metallic |
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 5. Identify and describe contact and non-contact seals | - Contact
  - Lip seals
  - Felt
  - Finger
  - Others
- Non-contact
  - Labyrinth
  - Annulus
  - Grease injected
  - Others |
| 6. Select seals, gaskets and packing | - Seals
- Packing
- Gaskets
- Compatibility
- Stamping (sizing) |

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:
- Select seals, gaskets and packing

**Conditions** As part of practical lab tasks, given the required tools and materials

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 2

Line (GAC): D LUBRICANTS, SEALS AND BEARINGS
Competency: D4 Install and Maintain Seals

Objectives
To be competent in this area, the individual must be able to:
• Correctly install, remove and maintain seals.

LEARNING TASKS
1. Perform seal installation and maintenance procedures

CONTENT
• Piston rings
  o Material
  o Installation
  o Measurement (inspection)
• Lip seals
  o Material
  o Installation
  o Inspection
  o Removal
• Rod wipers
  o Types
  o Installation
  o Inspection
  o Removal
• Mechanical seals
  o Installation
  o Inspection
  o Removal
  o Maintenance
• Packing installation and maintenance
  o Selection
  o Rings
  o V-packing
  o U-section packing
  o Cup packing
  o Jam packing
  o “O” rings

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Perform seal installation and maintenance procedures.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 2

Line (GAC): D LUBRICANTS, SEALS AND BEARINGS
Competency: D5 Select Bearings

Objectives
To be competent in this area, the individual must be able to:

- Describe various types of friction and load conditions associated with bearings.
- Identify styles and construction of friction and anti-friction bearings.
- Select the correct type of bearings for specific applications.

LEARNING TASKS

1. Describe bearings
   - Types of bearings
     - Friction
     - Anti-friction
   - Principles of operation
     - Sliding
     - Rolling
   - Types of loads
     - Radial
     - Thrust
     - Combination
   - Load contact
     - Point contact
     - Line contact

2. Describe friction bearings
   - Types
     - Bushing
     - Sleeve
     - Split
     - Precision insert
     - Multi-part
     - Half bearing
   - Housing styles
     - Flange
     - Pillow block
       - Split
       - Solid
       - Angle
       - Gib
     - Integrated
3. Describe friction bearing materials
   - Liner materials
     - Metallic
       - Babbitt
       - Lead
       - Bronze
       - Sintered Bronze
       - Brass
       - Silver
       - Cast iron
       - New alloys
     - Non-metallic
       - Nylon
       - Phenolic plastic
       - Polyurethane
       - Wood
       - Advanced plastics
     - Characteristics of liner materials
       - Embed ability
       - Score resistance
       - Fatigue resistance
       - Conformability
       - Compatibility
       - Abrasion resistance

4. Describe anti-friction bearings
   - Construction
     - Rolling elements
       - Ball
       - Roller
       - Spherical
       - Cylindrical
       - Tapered roller
     - Containment rings
       - Inner ring
       - Outer ring
       - Separating mechanism
       - Split bearings
     - Miscellaneous parts
       - Seals
       - Shields
     - Mounting styles
       - Taper bore
       - Straight bore
       - Mounting sleeve
       - Withdrawal sleeve

5. Select bearings based on application
   - Friction
   - Anti-friction
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  
  • Select bearings based on applications.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC):  D  LUBRICANTS, SEALS AND BEARINGS
Competency:  D6  Install and Maintain Bearings

Objectives
To be competent in this area, the individual must be able to:

- Fit, mount and dismount friction and anti-friction bearings.
- Inspect and maintain bearings and diagnose causes of bearing failures.

LEARNING TASKS CONTENT

1. Install and remove friction bearings

   - Fitting methods
     o Hand scraping
     o Machine fitting
     o Hydraulic assist
     o Bluing
   - Clearance requirements
     o Installed
     o Running
     o Plastigauge™
     o Lead wire
   - Positioning methods
     o Fixed
     o Floating
     o Locking rings
     o Hydraulic nut
     o Arbour press
   - Lubrication
     o Styles and position of lubrication grooves
     o Lubrication methods
     o Types of lubrication

2. Perform inspection and maintenance procedures on friction bearings

   - Inspection
     o Visual
     o Sound
     o Temperature
     o Vibration
     o Lubrication
   - Repair methods
     o Liner material
     o Shafts
     o Housings
3. Install and remove anti-friction bearings

- Fits and tolerances
  - Dimensions
  - Unilateral and bilateral
  - Limit of size
  - Allowance
  - Radial and axial clearance
  - Pre-load

- Allowances
  - Expansion fits
  - Shrink fits

- Application of fit tables

- Procedures for fitting
  - Induction heater
  - Oil bath
  - Checking clearances

- Positioning methods
  - Interference fit
  - Lock nuts
  - Shaft shoulders
  - Taper sleeves
  - Mounting sleeves
  - Collars
  - Retaining rings
  - Fixed and floating
  - Withdrawal sleeves

- Lubrication
  - Types of lubrication
  - Lubrication methods
    - Initial
    - Running
4. Perform inspection and maintenance procedures on anti-friction bearings

- Inspection
  - Visual
  - Sound
  - Vibration
  - Temperature
  - Clearance
  - Lubrication contamination
  - Irregularities

- Diagnosis of bearing problems
  - Oil discolouration
  - Load distribution
  - Spalling
  - Galling
  - Brinnelling
  - False brinnelling
  - Vibration analysis
  - Alignment
  - Monitoring equipment

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Install and remove friction bearings.
- Perform inspection and maintenance procedures on friction bearings.
- Install and remove anti-friction bearings.
- Perform inspection and maintenance procedures on anti-friction bearings.

Conditions As part of practical lab tasks, given the required tools and materials.

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): E INSTALL EQUIPMENT
Competency: E1 Use Safe Rigging Practices

Objectives
To be competent in this area, the individual must be able to:

- Describe the applicable WorkSafeBC regulations pertaining to rigging equipment and procedures.
- Describe the types and use wire and fibre rope.
- Identify the types and use rigging attachments.
- Identify and use hand rigging equipment and devices.
- Identify and use cranes.
- Devise or create a rigging plan.

LEARNING TASKS

1. Describe WorkSafeBC regulations
   - Responsibilities of
     - WorkSafeBC
     - Employer
     - Employee
     - Inspection requirements
       - Annual
       - Pre-use
       - Company specific requirement's (risk assessment)

2. Select, inspect and use fibre rope
   - Types and usage
     - Natural
     - Synthetic
   - Construction
   - Maintenance and storage
   - Design factors (working load limit)
   - Knots
     - Overhand
     - Figure 8
     - Square (reef)
     - Bow line
       - Normal
     - Single and double sheet bonds
     - Cats paw
     - Scaffold hitch
     - Truckers hitch
     - Timber hitch
3. Select, inspect and use wire rope
   - Types and usage
     - Fibre core
     - Hard core
   - Construction
   - Maintenance and storage
   - Design factors (working load limit)

4. Select, inspect and use slings
   - Fibre rope
   - Wire rope
   - Chain
   - Fibre mesh
   - Synthetic fibre web
   - Wire mesh
   - Maintenance and storage

5. Select, inspect and use rigging attachments
   - Spreader bars
   - Eye bolts
   - Hoist rings
   - Shackles
   - Hooks
   - End terminations
   - Turnbuckles
   - Blocks and pulleys
   - Maintenance and storage

6. Select, inspect and use hand rigging equipment
   - Storage and protection
   - Data plates (tags)
   - Replacement
   - WCB regulations
     - Hand signals
   - Types of hand rigging equipment
     - Jacks
     - Come-a-longs
     - Tirfors
     - Chain hoists
     - Winches
   - Maintenance and storage
7. Describe the use of cranes

- Types of cranes
  - Overhead
  - Conventional
  - Mobile Hydraulic
  - Tower
  - Boom trucks
  - Jib
  - Gantry
  - Hydraulic hoist

- WCB regulations
  - Hand signals

- Read and interpret load chart

- Perform pre-use inspection
  - fuel levels
  - tire pressure
  - absence of leaks

- Set up cranes
  - refer to load ratings for boom angles and distance
  - floats under outriggers, provide cribbing and dunnage

8. Create a rigging plan

- WCB regulations
- Safety requirements
- PPE requirements
- Establish communication
  - line of sight / hand signals
  - two-way radio

- Read and interpret load charts
- Determining stress on slings and attachments
- Sling angles
- Determine centre of gravity
- Stability triangle
- Determine weight to be lifted
  - scale / load cells
  - dynamometers
  - name plate
  - manufacturer’s manual
- Transporting equipment
- Secure lift radius
- Determine weather and ground conditions
- Site evaluation
- Post inspection
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Inspect and use hand rigging equipment and devices.
  • Create a rigging plan.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): E INSTALL EQUIPMENT
Competency: E2 Describe Layout and Securing of Equipment

Objectives
To be competent in this area, the individual must be able to:

- Demonstrate the use of layout tools and describe appropriate layout procedures for the installation of machinery.
- Describe various types of equipment-mounting fastening devices.
- Explain the safe use and handling of grouts.

LEARNING TASKS

1. Identify layout tools

   CONTENT
   - Tools
     - Measuring tapes
     - Gauges
     - Levels
       - Spirit
       - Optical
       - Laser
     - Transits
     - Piano wire
     - Plumb bobs
     - Straight edges

2. Describe equipment layout procedures

   CONTENT
   - Maintenance procedures
   - Layout procedures
     - Machine location and alignment to associated equipment
     - Machine bases
     - Installation of machine components
       - Base lines and centre lines
       - Lines with piano wire
       - Check lines with 3, 4, 5 and swing arc
       - Angular lines
   - Check out layout accuracy
3. Describe methods of securing equipment

- Anchor bolts / systems
  - Types of anchors
    - Expansion shield
    - Solid slug-ins
    - Leaded
    - Toggle
    - Boxed bolts
    - Hooks and tees
  - Types of anchor bolts
    - Fixed
    - Pipe or tube
    - Boxed
  - Installation of anchors
    - Design bolts
    - Selection for specific job
    - Installation with no foundation

- Grouts
  - Foundation (clean and rough up base)
  - Types and properties
  - Thickness
  - Requirements
  - Mixing
  - Placing
    - Finishing

Achievement Criteria

Performance
The learner will be evaluated on the ability to:
- Demonstrate the use of layout tools for the installation of machinery
- Perform layout procedures for the installation of machinery.

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 2

Line (GAC): E INSTALL EQUIPMENT
Competency: E3 Describe Equipment Foundations

Objectives
To be competent in this area, the individual must be able to:

• Describe equipment foundations and associated materials.
• Prepare the layout for the installation of equipment foundations.

LEARNING TASKS CONTENT
1. Describe equipment foundations
   • Foundation materials
     o Concrete
     o Reinforced concrete
     o Steel / wood
   • Cast
   • Sole plates
   • Fabricated
   • Skid mounted
   • Grouts
     o Foundation (clean and rough up base)
     o Types and properties
     o Thickness
     o Requirements
     o Mixing
     o Placing
     o Finishing
Line (GAC): E INSTALL EQUIPMENT
Competency: E4 Explain Levelling and Alignment Procedures

Objectives
To be competent in this area, the individual must be able to:

- Identify the appropriate tools required to facilitate machine installation.
- Describe setting, positioning, levelling and aligning equipment.

LEARNING TASKS

1. Identify levelling and alignment tools
2. Describe levelling and alignment procedures

CONTENT

- Alignment tools
  - Types
  - Uses
  - Care
  - Maintenance

- Establish machine reference points
  - Centre lines
  - Base lines
  - Elevation marks

- Set elevation and position
  - Engineers reference point
  - Bench mark
  - Piano wire
  - Laser level
  - Optical level
  - Straight edge
  - Machinist level
  - Jig transit

- Procedures for levelling equipment
  - Instruments
  - Shims
  - Jacking screws
  - Self levelling

- Procedures for various machine components
  - Rolls
  - Hubs
  - Bearings
  - Sprockets
  - Sheaves
  - Reduction units
  - Machine bases and sub-bases
  - Rails
Program Content
Level 2

Line (GAC): F CUT, FIT AND FABRICATE
Competency: F3 Use and Maintain Shielded Metal Arc Welding (SMAW)

Objectives
To be competent in this area, the individual must be able to:

- Perform vertical shielded metal arc welding.

LEARNING TASKS

1. Describe vertical shielded metal arc welding equipment
   - Associated equipment
     - Electrode holders
     - Ground clamps
     - Cables
   - Electrodes
     - Correct handling and storage
     - Select for specific application

2. Perform vertical shielded metal arc welding
   - Set up
     - Identify unsafe SMAW equipment
   - Basic joint design
   - Weld types, sizes and profiles
   - Vertical welding positions
   - Weld faults
     - Undercuts
     - Porosity
     - Inclusions
     - Voids
   - Methods of distortion control
     - Fit
   - Shut down

Achievement Criteria

Performance
The learner will be evaluated on the ability to:
- Perform vertical shielded metal arc welding.

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): F  CUT, FIT AND FABRICATE
Competency: F5  Use and Maintain Gas Metal Arc Welding (GMAW or MIG) and Gas Tungsten Arc Welding (GTAW (TIG)) equipment

Objectives
To be competent in this area, the individual must be able to:

• Identify gas metal arc welding (GMAW or MIG) equipment.
• Identify gas tungsten arc welding (GTAW (TIG)) equipment.
• Perform gas metal arc welding.
• Perform gas tungsten arc welding.
• Maintain gas metal arc welding (GMAW or MIG) and gas tungsten arc welding (GTAW (TIG)) equipment.

LEARNING TASKS

1. Explain principles of Gas Metal Arc Welding (GMAW) and / or Metal Inert Gas Welding (MIG) and Gas Tungsten Arc Welding (GTAW (TIG))
   • Principles of operation
   • Modes of metal transfer
   • Hard surfacing

2. Identify, set up and maintain welding equipment
   • Power sources
   • Wire feed system
     o Wire feed and speed
     o Amperage
   • Shielding gases
   • Gun assemblies
   • Set up equipment
   • Wire types and sizes
   • Set up
   • Maintenance

3. Describe theory and perform basic welding
   • Basic joint design
   • Weld types, sizes and profiles
   • Welding positions
     o Flat
     o Horizontal
     o Vertical
   • Weld faults
     o Undercuts
     o Porosity
     o Inclusions
     o Voids
   • Methods of distortion control
   • Shut down
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Perform gas metal arc welding.
  • Perform gas tungsten arc welding.
  • Maintain gas metal arc welding (GMAW or MIG) and gas tungsten arc welding (GTAW (TIG)) equipment

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Line (GAC): H SERVICE POWER TRANSMISSIONS
Competency: H7 Service Drive Shafts

Objectives
To be competent in this area, the individual must be able to:
- Install and fit keys, key ways and key seats.
- Define shaft terminology.
- Identify types of shafting and shaft attachments.
- Service shafts and shaft attachments.

LEARNING TASKS

1. Describe and install keys, key ways and key seats
   - Types
     - Keys
     - Key seats/key ways
     - Taper keys
   - Uses
   - Standard sizes
   - Set screws
   - Procedures
     - Selection of keys
     - Cutting key seats and key ways
       - Portable milling machines
       - Broach and arbor press
     - Removal
     - Installation
     - Fitting
     - Securing

2. Identifies and services shafts and shaft attachments
   - Shaft types
     - Drive
     - Counter
     - Jack
     - Hollow
   - Shafting
     - Types
     - Uses
     - Sizes
     - Identification
     - Stresses
       - Types
       - Source
       - Reduction
       - Bearing placement
       - Maintenance
       - Shaft repair methods
         - Straightening
LEARNING TASKS

CONTENT

- Spray welding

- Attachments
  - Bearings
  - Hubs
  - Couplings
  - Sprockets
  - Gears
  - Compression fittings
  - Taper lock bushings

- Attachment installation
  - Fits and tolerances
  - Expansion fitting
  - Shrink fitting
  - Concentricity

- Attachment removal
  - Pullers
  - Hydraulic press
  - Heat
  - Cooling
  - Hydraulic assist

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Install and fit keys, key ways and key seats.
- Service shafts and shaft attachments.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): I SERVICE FLUID POWER
Competency: I1 Explain Hydraulic Theory

Objectives
To be competent in this area, the individual must be able to:

- Define the terminology used in hydraulic systems.
- Explain the relevance of the laws and principles of hydraulics.
- Explain fluid flow and flow paths.

LEARNING TASKS

1. Describe the principles of fluid power
   - Laws and Principles
     - Pascal's Law
     - Bernoulli's Principle
     - Newton's Law of conservation of energy
     - Multiplication forces
   - Terminology
     - Hydrodynamic
     - Hydrostatic
     - Atmospheric pressure
     - Suction
     - Head
     - Cavitation
     - Lift
   - Identify the measurements used with vacuum and pressure
   - Input-output components
   - Advantages and disadvantages of hydraulics over other power sources

2. Explain the relationship of flow and flow paths
   - Fluid flow
   - Creation of pressure
   - Series flow paths
   - Parallel flow paths
   - Pressure drop
   - Laminar and turbulent flow
LINE (GAC): I SERVICE FLUID POWER
Competency: I2 Interpret Hydraulic Schematics

Objectives
To be competent in this area, the individual must be able to:

- Identify and use schematic and graphical symbols used in hydraulic circuitry as it pertains to JIC and ISO standards.

LEARNING TASKS CONTENT

1. Identify and use hydraulic schematic symbols

   • Standard graphic symbols
     - JIC (Joint Industry Conference)
     - ANSI (American National Standards Association)
     - ISO (International Standards Organization)

Achievement Criteria

Performance
The learner will be evaluated on the ability to:

- Use hydraulic schematic symbols.

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 2

Line (GAC): I SERVICE FLUID POWER
Competency: I3 Describe Hydraulic Components

Objectives
To be competent in this area, the individual must be able to:

• Describe hydraulic fluids and their application.
• Describe types of filtering and conditioning of fluids.
• Describe styles and uses of conductors and their fittings.
• Describe reservoirs and their purpose in the system.
• Describe actuators and their purpose.
• Describe valves and their purpose.
• Describe accessories and their purpose.

LEARNING TASKS

1. Identify and describe hydraulic fluids

   CONTENT
   • Fluid bases
     o Petroleum mixtures
     o Synthetic fire resistant fluids
     o Storage and handling
   • Qualities required for:
     o Power transmission
     o Lubrication
     o Sealing
     o Cooling
   • Additives for fluids
   • Viscosity
   • Oxidation catalysts

2. Describe fluid conditioners

   CONTENT
   • Identify
     o Filters
     o Strainers
     o Filtering materials
   • Concept of mesh and micron ratings
   • Effectiveness of filter and strainer positions
   • Methods of full flow and proportional filtering
   • Heat exchangers

3. Describe fluid conductors

   CONTENT
   • Piping
     o Sizes
     o Types
     o Schedules
     o Fittings
     o Sealing
     o Compatibility with fluids
     o Applications
     o Installation
LEARNING TASKS

CONTENT

- Tubing
  - Sizes
  - Types
  - Measurement
  - Fittings
  - Compatibility with fluids
  - Applications
  - Installation

- Hoses
  - Parts
  - Construction
  - Pressure and flow considerations
  - Types of fittings
  - Compatibility with fluids
  - Applications
  - Installation

- Sealing
  - Internal
  - External
  - Types of seals
  - Static seals
  - Dynamic seals
  - Considerations for leak prevention

4. Describe reservoirs

- Styles of reservoirs
  - Conventional
  - Overhead
  - L-shaped

- Components
  - Baffle plates
  - Breather
  - Sight glass
  - Filler hole
  - Drain plug
  - Magnetic plug
  - Paint sealer
  - Temperature gauge
  - Removable cover

- Size requirements

5. Describe actuators

- Rotary
  - Gear
  - Vane
  - Piston
  - Construction
  - Displacement
  - Torque rating
### LEARNING TASKS

#### CONTENT

- Linear
  - Single acting
  - Double acting
  - Differential
  - Non-differential
  - Ram
  - Telescoping construction
  - Load
  - Speed
  - Mounting styles

6. Describe hydraulic valves

- Check valves
- Directional control valves
  - Classifications
  - Spool types
  - Methods of operation
- Servo valves
- Pressure actuated valves
  - Relief
  - Unloading
  - Sequence
  - Pressure reducing
  - Brake
  - Location
  - Operation
- Volume control valves

7. Describe hydraulic accessories

- Accumulators
  - Purpose
  - Weighted
  - Spring
  - Gas charged
- Intensifiers
  - Purpose
  - Function
- Switches
  - Purpose
  - Function
  - Styles
- Gauges
  - Purpose
  - Function
  - Styles
Line (GAC):  I  SERVICE FLUID POWER
Competency:  I4  Identify Hydraulic Pumps

Objectives
To be competent in this area, the individual must be able to:

- Explain the operating principles of hydraulic pumps.
- Identify the types of pumps used in hydraulic systems.

LEARNING TASKS
1. Describe hydraulic pumps

CONTENT
- Operating principles
  - Hydro dynamic
  - Hydro static
- Types of pumps
  - Gear pumps
    - Internal
    - External
  - Vane pumps
    - Balanced
    - Unbalanced
    - Vane design
    - Cartridge
  - Piston pumps
    - Radial
    - Axial
- Pump ratings
  - Displacement
  - Flow rate
  - Volumetric efficiency
Level 3
Millwright
Program Content
Level 3

Line (GAC): E INSTALL EQUIPMENT
Competency: E5 Level, Align and Secure Equipment

Objectives
To be competent in this area, the individual must be able to:

• Describe coupling and shaft alignment procedures.
• Demonstrate the use of tools used for coupling and shaft alignment procedures.
• Demonstrate coupling and shaft alignment procedures and the keeping of installation records.
• Explain alignment and installation records and demonstrate the keeping of installation records.

LEARNING TASKS

1. Demonstrate alignment procedures for rotating equipment
   • Procedures for equipment alignment
     o Instruments
     o Shims
     o Jacking screws
     o Laser

2. Use equipment alignment procedures
   • Alignment equipment
     o Various types
     o Selection
     o Checking and maintaining
     o Care
     o Mounting
     o Shims
     o Jacking screws
   • Procedures for various machine components
     o Rolls
     o Hubs
     o Bearings
     o Sprockets
     o Sheaves
     o Reduction units
     o Machine bases and sub-bases
     o Rails

3. Demonstrate knowledge of types of misalignment and how to correct them
   • Types of misalignment
     o Angular
     o Offset
     o Combination
     o Deliberate
LEARNING TASKS

4. Demonstrate alignment procedures and record keeping

CONTENT

- Procedures
  - Soft foot
  - Rough alignment
  - Rim and face
  - Reverse reading
  - Graph alignment
  - Computer alignment
  - Laser alignment
- Maintenance records
- Update mechanical drawings to reflect as-built (red line)

Achievement Criteria

Performance  The learner will be evaluated on the ability to:
- Use tools for coupling and shaft alignment procedures.
- Perform coupling and shaft alignment
- Update maintenance and installation records.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria   Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): H SERVICE POWER TRANSMISSIONS
Competency: H1 Describe Power Transmission Theory

Objectives
To be competent in this area, the individual must be able to:

- Explain the relationship between speed, torque and horsepower as related to power transmission devices.
- Explain how to calculate speed ratios of power transmission devices.

LEARNING TASKS

1. Explain the theory and perform calculations related to power

   - Speed
   - Torque
   - Horsepower
   - Ratios

2. Explain and perform calculations related to power transmission and motion control systems

   - Force
     - Weight
     - Mass
     - Measuring units
     - Force transformers
   - Work
     - Efficiency
   - Rate
     - Linear speed
     - Rotational speed
     - Thermal
     - Electrical
     - Flow
   - Energy
     - Gravitational
     - Linear (kinetic energy)
     - Moment of inertia
     - Potential energy
   - Power
     - Mechanical
     - Fluid
Line (GAC): H SERVICE POWER TRANSMISSIONS
Competency: H2 Service Couplings

Objectives
To be competent in this area, the individual must be able to:
- Identify different types of couplings.
- Assemble, install and maintain couplings.
- Recognize coupling failure and diagnose problems.

LEARNING TASKS
1. Describe couplings

CONTENT
- Purpose
  - Rigid couplings
  - Flexible couplings
- Rigid types
  - Clamp
  - Muff
  - Flange
  - Shop made
- Mechanical flexible types
  - Metallic
    - Slider
    - Chain
    - Metallic grid
    - Gear
    - Spacer
    - Pin and link
    - Floating shaft
    - Laminated
    - Disk
    - Universal joint
  - Non-metallic
    - Pin and bushing
    - Pin and disc
    - Elastomer
- Centrifugal type
  - Fluid
  - Dry fluid
  - Centrifugal
- Vibration
LEARNING TASKS

2. Maintain couplings

CONTENT

- Installation procedures
- Removal procedures
- Assembly and alignment
- Maintenance
  - Flexible
  - Rigid
- Diagnosis of:
  - Failures
  - Causes of failure
    - Misalignment
    - Incorrect assembly
    - Lack of lubrication
- Troubleshooting
  - Wear
  - Noise

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Assemble, install and maintain couplings.
- Diagnose coupling failure.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 3

Line (GAC): H  SERVICE POWER TRANSMISSIONS
Competency: H3  Service Gear Drives

Objectives
To be competent in this area, the individual must be able to:

• Define gear terminology and identify types and arrangements of gears and gear drives.
• Inspect and service gear drives.

LEARNING TASKS

1. Describe gear terminology

CONTENT
• Associated with gears
  o Addendum
  o Dedendum
  o Circular pitch
  o Whole depth
  o Outside diameter
  o Pitch circle diameter
  o Clearance
  o Pitch circle
  o Line contact
  o Root diameter
  o Pressure angle
  o Pitch
  o Working depth
  o Hand
  o Involute

• Associated with reduction units
  o Back lash
  o Hand
  o Mesh
  o Compound reduction
  o Idler gears
  o Contact

2. Describe characteristics and use of gears

• Types
  o Spur
  o Rack and pinion
  o Internal spur
  o Helical
  o Herring bone
  o Bevel
  o Worm and wheel
  o Hypoid
  o Spiral bevel
  o Planetary
  o Cycloid

• Shaft positions for different gears
  o Parallel
  o Intersecting
  o Crossing
LEARNING TASKS

CONTENT

- Tooth profiles and action
  - Spur gears
  - Helical gears
  - Worm and wheel
  - Hypoid

- Gear materials
  - Ferrous
  - Non-ferrous
  - Non-metallic

- Gear calculations
  - Size
  - Clearance
  - Pitch
  - Diometrical pitch
  - Pitch diameter
  - Outside diameter
  - Center distance
  - Addendum
  - Dedendum

- Calculate speeds and ratios
  - Simple gear drives
  - Compound gear drive

3. Describe gear drives and reduction units

- Identification
  - Types
  - Hand

- Installation
  - Mounting
    - Alignment
    - Permanent location
    - Shaft mounted
  - Attachments
  - Assembly
  - Inspection

- Lubrication
  - Methods
  - Inspection

- Bearings
  - Types
  - End float
  - Clearance

- Seals
  - Location
  - Installation
LEARNING TASKS

4. Inspect and service gear drives

CONTENT

- Safety
  - Precautions
  - Guards

- Inspection and repair
  - Dismantling reduction unit
  - Dowels
  - Noise
  - Vibration
  - Heat
  - Lubrication
  - Wear patterns
  - Backlash
  - Effects on bearings and seals

- Gear mesh
  - Backlash
  - Gear contact
  - Wear patterns

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Inspect and service gear drives.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Objectives
To be competent in this area, the individual must be able to:

• Define belt drive terminology and identify types and arrangements of belt drives.
• Install and service belt drives.

LEARNING TASKS

1. Describe belt drives

   • Terminology
     o Tension
     o Arc of contact
     o Area of contact
     o Creep
     o Pitch line
     o Idler
     o Compression section
     o Tension section
     o Pitch
     o Coefficient of friction
     o Neutral section
     o Ply
     o Sheaves
     o Pulley
     o Elongation
     o Rim speed

   • Principles of belt drive operation
     o Area of contact
     o Belt tension
     o Friction
     o Belt to pulley
     o Belt to sheave
     o Guidelines
     o Belt speed
     o Power record keeping

   • Advantages and disadvantages
     o Flat belts
     o V-belts
LEARNING TASKS

2. Describe flat belt drive systems

- Belts
  - Types
  - Identification
  - Construction
  - Joining
    - Vulcanized
    - Mechanical fasteners
    - Splicing
  - Storage
- Sheaves
  - Construction and shape
  - Diameters for belt life and rim speed
  - Materials
  - Mounting
  - Speed calculations
  - Effects of pitch diameter on belts
  - Idler shafts
  - Specifications
  - Applications
  - Selection crowning
  - Coned pulleys

3. Describe V-belt drive systems

- Types of V-belts
  - Link
  - Notched
  - Positive drive
  - Variable speed belts
  - Power band belts
  - Double V
  - Conventional
  - Serpentine
- V-belt construction
- V-belt storage
- Pulleys
  - Construction
  - Required size calculations
  - Relationship between size and belt speed
  - Application
  - Specifications
  - Selection
LEARNING TASKS

4. Perform belt drive calculations

- Speeds
  - Ratios
  - Simple reductions
  - Compound reductions
  - Belt velocity
  - R.P.M.

- Belt installation
  - Arc of contact
  - Belt length
  - Tension
  - Center distance

5. Install and maintain belt drives

- Drive installation
  - Alignment
  - Belt selection
  - Belt adjustment
  - Belt tension adjustment devices
  - Sheave installation

- Drive maintenance
  - Inspection
  - Tension adjustment
  - Alignment
  - Sheave removal
  - Taper lock
  - Locational fit

6. Describe variable speed drives

- Variable speed belts
  - Types
  - Profiles
  - Codes

- Types of Variable speed sheaves
  - Compound
  - Spring loaded
  - Installation

- Variable speed drives
  - Identification
  - Hub forces
  - Principle of operation
    - Cone drives
    - Metal belts
    - Geared differential drives
    - Traction drives
LEARNING TASKS

7. Maintain variable speed drives

CONTENT

- Lockout
- Safety precautions
- Adjustments
- Drive installation
- Sheave maintenance
- Belt inspection

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Install and maintain belt drives
- Maintain variable speed drives.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): H SERVICE POWER TRANSMISSIONS
Competency: H5 Service Clutches and Brakes

Objectives
To be competent in this area, the individual must be able to:

- Identify clutches and brakes.
- Install, service and maintain clutches and brakes.

LEARNING TASKS

1. Describe clutches and brakes
   - Construction and operation
     - Mechanical
       - Rigid
       - Flexible
       - Positive
       - Friction
       - Overrunning
     - Fluid
       - Hydraulic
       - Lead shot
     - Pneumatic
       - Disc
       - Drum
     - Electrical
       - Disc
       - Drum
       - Band
   - Selection for applications
     - Load
     - Speed
     - Directional requirements
   - Clutches used as brakes

2. Inspect and maintain clutches
   - Safety requirements
   - Procedures for:
     - Inspection
     - Installation
     - Removal
     - Testing

3. Inspect and maintain brakes
   - Safety requirements
   - Procedures for:
     - Inspection
     - Installation
     - Removal
     - Testing
     - Intermittent
     - Continuously running
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  - Install, service and maintain clutches and brakes.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC):     H     SERVICE POWER TRANSMISSIONS
Competency:     H6     Service Chain Drives

Objectives
To be competent in this area, the individual must be able to:

- Define chain drive terminology and identify types and arrangements of chains and chain drives.
- Install, inspect and maintain chains and chain drives.

LEARNING TASKS
1. Describe drive chains

CONTENT
- Terminology
  - Roller link
  - Plate link
  - Offset link
  - ANSI
  - ISO
  - Chain codes
  - Bushing
  - Sprocket
  - Slack
  - Idler
  - Pitch
  - Multiple pitch
- Drive chain types
  - Standard
  - Roller less
  - Heavy series
  - Light weight
  - Multiple strand
  - Double pitch
  - Self-lubricated
  - Silent
  - H-class or pintle
- Describe chain uses:
  - Function or purpose
  - Chain service
  - Selection
  - Application
LEARNING TASKS

2. Describe chain drive assembly
   - Describe sprockets
     - Types
     - Identification
     - Selection
     - Application
     - Installation
     - Removal
   - Calculate chain drive problems
     - Speeds
     - Chain lengths
     - Sprocket sizes
     - Center distance
     - Chain Slack
     - Tension requirements
   - Horsepower/torque requirements
   - Drive chain assembly
     - Design
       - Arrangement
       - Factors
       - Advantages and disadvantages
     - Tensioning devices
     - Alignment
       - Sprockets
       - Shafts
       - Drive assembly
     - Chain joining
     - Lubrication

3. Inspect, install and maintain chain drives
   - Safety requirements
   - Drive inspection
   - Troubleshooting
   - Lubrication
   - Alignment
   - Sprocket installation
   - Chain replacement
   - Installation

Achievement Criteria

Performance The learner will be evaluated on the ability to:
   - Install, inspect and maintain chains and chain drives

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC):  I  SERVICE FLUID POWER
Competency:  I5  Describe, Assemble and Maintain Hydraulic Circuits

Objectives
To be competent in this area, the individual must be able to:
• Describe and design hydraulic circuitry.
• Assemble basic hydraulic circuitry.
• Maintain and service hydraulic systems and circuits.
• Diagnose faults associated with hydraulic circuits.
• Calibrate, set and adjust hydraulic circuits.

LEARNING TASKS

1. Describe and design basic circuits
   • Basic linear
   • Basic rotary
   • Regeneration
   • Sequence
   • Reduced pressure
   • Pressure activated
   • Speed control

2. Assemble basic hydraulic circuits
   • Basic linear
   • Basic rotary
   • Regeneration
   • Sequence
   • Pressure activated
   • Speed control
   • Reduced pressure

3. Maintain and diagnose hydraulic systems
   • Safety requirements
   • Tools required
   • Testing equipment
   • Diagnostics
   • Adjustment and calibration
   • Schematic interpretation
   • Identify system failure causes
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  - Design hydraulic circuitry
  - Assemble basic hydraulic circuitry.
  - Maintain and service hydraulic systems and circuits.
  - Diagnose faults associated with hydraulic circuits.
  - Calibrate, set and adjust hydraulic circuits.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 3

Line (GAC): K SERVICE PUMPS
Competency: K1 Explain Pump Theory

Objectives
To be competent in this area, the individual must be able to:

• Explain terminology associated with pumps.
• Describe the operation of pumps.

LEARNING TASKS CONTENT
1. Describe the theory of pump operation

• Terminology
  o Static
    – Lift
    – Head discharge head
    – Suction head
  o Dynamic
    – Lift
    – Head discharge head
    – Suction head
  o Total head
  o Cavitation
  o Positive displacement
  o Non-positive displacement

• Operating principles and basic theory
  o Positive displacement
  o Non-positive displacement
  o Relationship of pressure and flow
  o Pump calculations
Line (GAC): K SERVICE PUMPS
Competency: K2 Identify Types of Pumps

Objectives
To be competent in this area, the individual must be able to:

- Explain the advantages and disadvantages of positive and non-positive displacement pumps.
- Identify the major components of pumps.
- Explain the application different types of pump materials.

LEARNING TASKS

1. Identify different styles of pumps
   
   CONTENT
   
   - Styles of pumps
     - Positive displacement
     - Non-positive displacement
     - Multi-stage
     - Single stage
     - Advantages/disadvantages/application
       - Multi stage
       - Single stage
   
   - Major components
     - Positive displacement
     - Non-positive displacement
   
   - Application of different types of pump materials
     - Cast iron
     - Stainless steel
     - Rubber
     - Plastic
     - Exotic metals
   
   - Pump selection
     - Limitations
     - Condition of flow
     - Pulsation
     - Structural considerations
     - Products pumped
       - Hydro carbons
       - Corrosives
       - Water
       - Slurries
       - Pulpy solids
       - High temperature products
Line (GAC): K SERVICE PUMPS
Competency: K3 Install, Maintain and Troubleshoot Positive Displacement Pumps

Objectives
To be competent in this area, the individual must be able to:

- Select and install positive displacement pumps based on the application.
- Diagnose and correct pump faults and pumping problems associated with positive displacement pumps.

LEARNING TASKS

1. Install and maintain positive displacement pumps
   - Specifications
     - Displacement capacity
     - Lift capacity
     - Static head
   - Maintenance
     - Alignment
     - Sealing
     - Lubrication
     - Removing air

2. Troubleshoot positive displacement pumps
   - Safety requirements
   - Failure to pump
   - Air in the system
   - Leakage
   - Excessive noise
   - Excessive vibration
   - Excessive force to turn
   - Loss of pressure
   - Hot bearings
   - Internal slippage
   - Wear
   - Wear location
   - Compression packing
   - Mechanical seals
   - Lip seals
   - Volumetric efficiency
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Install and maintain positive displacement pumps
  • Troubleshoot positive displacement pumps.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): K SERVICE PUMPS
Competency: K4 Install, Maintain and Troubleshoot Non-Positive Displacement Pumps

Objectives
To be competent in this area, the individual must be able to:

- Select and install non-positive displacement pumps based on the application.
- Diagnose and correct pump faults and pumping problems associated with non-positive displacement pumps.

LEARNING TASKS

1. Install and maintain non-positive displacement pumps

   CONTENT
   - Specifications
     - Displacement capacity
     - Lift capacity
     - Static head
   - Maintenance
     - Alignment
     - Sealing
     - Lubrication
     - Removing air

2. Troubleshoot non-positive displacement pumps

   CONTENT
   - Safety requirements
   - Failure to pump
   - Air in the system
   - Leakage
   - Excessive noise
   - Excessive vibration
   - Excessive force to turn
   - Loss of pressure
   - Hot bearings
   - Internal slippage
   - Wear
   - Wear location
   - Compression packing
   - Mechanical seals
   - Lip seals
   - Volumetric efficiency
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Install and maintain non-positive displacement pumps
  • Troubleshoot non-positive displacement pumps.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 3

Line (GAC): L  SERVICE MATERIAL HANDLING SYSTEMS
Competency: L1  Explain Material Handling Theory

Objectives
To be competent in this area, the individual must be able to:

- Explain material handling requirements for various industries.
- Identify material handling systems for different products.

**LEARNING TASKS**

1. Describe different types of material handling

   - Conveyors
   - Bulk handling equipment
     - Ship
   - Blowers
   - Wire Cables
   - Fluidized materials
     - Pneumatic conveyor systems
     - Vacuum conveyor systems

2. Identify various types of conveyor systems

   - Bulk loading
     - Belt
     - Screw
     - Bucket
     - Pneumatic
     - Chain
     - Elevator
   - Solid material or package loads
     - Chain
     - Roller
     - Roll cases
     - Transfer tables
     - Elevator
     - Belt
     - Monorail
Line (GAC): L
Service Material Handling Systems
Competency: L2 Maintain Fans and Blowers

Objectives
To be competent in this area, the individual must be able to:

- Describe, maintain and service fans.
- Describe, maintain and service blowers.

LEARNING TASKS

1. Describe classifications and types of fans and fan systems
   - Classification of fans
     - Axial
     - Centrifugal
   - Axial flow
     - Free flow
     - Diaphragm mounted
     - Ducted
     - Vane
   - Centrifugal flow
     - Radial
     - Air foil
     - Forward curved
     - Backward curved
   - Induction, balanced and forced draft

2. Maintain and service fans
   - Safety requirements
   - Ventilation and pollution control
     - Environment Canada regulations
     - Scrubbers
     - Electrostatic precipitators
     - Bag house
     - Cyclonic separators
   - Read service manuals
   - Explain fan specifications
   - Maintenance checks
     - Alignment
     - Vibration
     - Wear
     - Noise

3. Describe the types of blowers
   - Lobe
   - Screw
Program Content Level 3

LEARNING TASKS
4. Maintain and service blowers

CONTENT
- Safety requirements
- Ventilation and pollution control
  - Environment Canada regulations
  - Scrubbers
  - Electrostatic precipitators
  - Bag house
  - Cyclonic separators
- Read service manuals
- Explain blower specifications
- Maintenance checks
  - Alignment
  - Vibration
  - Wear
  - Noise
  - Timing

Achievement Criteria
Performance The learner will be evaluated on the ability to:
- Maintain and service fans.
- Maintain and service blowers.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): L   SERVICE MATERIAL HANDLING SYSTEMS
Competency: L3  Identify Types of Conveyors

Objectives
To be competent in this area, the individual must be able to:

- Identify types of conveyors and their components.
- Describe the use of different types of conveyors in industrial settings.

LEARNING TASKS

1. Identify belt conveyors and components

   - Belt types
     - Standard
     - Reduced ply
     - Solid woven
     - Cord carcass
     - Thin
     - Cable
   - Pulleys
     - Head
     - Drive
     - Snub
     - Return
     - Crown
     - Tail
     - Tracking
   - Idlers
     - Transition
     - Carrying
     - Side guide
     - Return
     - Self aligning
     - Impact
   - Tensioning devices
     - Screw take-ups
     - Gravity
     - Hydraulic
     - Pneumatic
     - Weighted
   - Miscellaneous components
     - Safety devices
     - Scrapers
     - Belt cleaners
   - Drive styles
     - S-drive
     - Double drive
     - Tandem drive
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<td>3. Identify screw conveyors and components</td>
<td>• Terminology</td>
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<td>4. Identify chain conveyors and components</td>
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<td>5. Identify pneumatic conveying systems</td>
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<td>o Vacuum</td>
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<td>• System components</td>
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<td>LEARNING TASKS</td>
<td>CONTENT</td>
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</table>
| 6. Identify roller conveyors and components | **Gravity powered**  
| | o Components  
| | o Load ratings  
| | **Powered roller conveyors**  
| | o Components  
| | o Belt position  
| | o Drive position  
| | o Load rating  
| 7. Identify roll case conveyors and components | **Types**  
| | o Standard (transfer)  
| | o Bottle  
| | o Eccentric (off centre)  
| | o Guide  
| | **Components**  
| | o Rolls  
| | o Drives  
| | o Accessories  
| 8. Identify transfer table conveyors and components | **Types**  
| | **Components**  
| | o Drives  
| | o Tracks  
| | o Chain  
| | o Belt  
| | o Slack controllers  
| | o Lifts  
| | − Hydraulic  
| | − Pneumatic  
| 9. Identify monorail systems and their components | **Types**  
| | **Components**  
| | o Rails  
| | o Chains  
| | o Drives  
| | o Take-up  
| | o Hangers  


Line (GAC): L  SERVICE MATERIAL HANDLING SYSTEMS
Competency: L4 Describe Methods of Conveyor Loading and Unloading, and Types of Process Tanks and Storage Containers

Objectives
To be competent in this area, the individual must be able to:

- Describe the functions and methods of loading and unloading material handling systems.
- Describe the types and functions of process tanks and storage containers
- Diagnose, repair and maintain process tanks and containers
- Describe, maintain and identify the various types and components of material handling systems
- Describe the standard operating procedures for tanks and process vessels for confined space entry

LEARNING TASKS

1. Describe methods of loading and unloading conveyors
   - Chutes
   - Feeders
     - Low pressure
     - High pressure
     - Blow tank feeders
     - Hydraulic
   - Baffles
   - Skirting
   - Trippers
   - Cyclones
   - Ploughs
   - Screens

2. Describe types of process tanks and containers
   - Types of bins and hoppers
   - Cyclones
   - Separators
   - Pollution control equipment
   - Agitators
   - Vents
   - Pumps
   - Piping
   - Level indicators
3. Diagnose process tanks and containers

- Diagnose problems and symptoms
- Inspect components
  - filters
  - strainers
  - piping
  - agitators
  - vents
  - level indicators
- NDT or condition-based monitoring requirements
- Type of repairs
  - patching
  - overlay
  - re-coating
  - piping
- Failure or breakdown conditions

4. Describe repair procedures process tanks and containers

- Tools and equipment
- Refurbish or replace defective components
- Measure component dimensions
- Adjust components
- Lubricate components

5. Describe maintenance procedures for tanks and containers

- Sensory inspection
  - Condition-based monitoring tools
  - NDT
- Verify maintenance requirements according to manufacturers’ specifications
- Clean or replace oil filters and strainers
- Check fluid levels
- Check temperatures, pressures, vacuum and flow rates
- Verify valve operation
- Adjust process tank and container components
  - Pressure relief valves
  - Holes
- Component clearances according to manufacturers’ specifications
- Change liners
- Clear ventilation systems of blockages
Program Content
Level 3

Line (GAC): L SERVICE MATERIAL HANDLING SYSTEMS
Competency: L5 Maintain Conveyor Systems

Objectives
To be competent in this area, the individual must be able to:

- Recognize hazards and implement safety requirements associated with the maintenance of material handling systems.
- Describe the service and repair of belt conveyor components.
- Describe the service and repair of bucket conveyor components.
- Describe the service and repair of chain conveyor components.
- Describe the service and repair of pneumatic conveyor components.
- Describe the service and repair of roller and roll case conveyor components.
- Describe the service and repair of transfer table components.
- Describe the service and repair of monorail conveyor components.

LEARNING TASKS

1. Service and maintain belt conveyors
   - Safety requirements
   - Safety devices
   - Splices
     - Mechanical
     - Lacing
     - Vulcanized
     - Lagging
   - Idlers
   - Repairs
   - Alignment/tracking
   - Drives
   - Maintenance
   - Lubrication
   - Lacing (leather)

2. Service and maintain bucket elevators
   - Safety requirements
   - Belt
   - Chain
   - Buckets
   - Head assembly
   - Drives

3. Service and maintain chain conveyors
   - Safety requirements
   - Chain wear
   - Sprocket wear
   - Alignment
   - Lubrication
## LEARNING TASKS

<table>
<thead>
<tr>
<th>Task Number</th>
<th>Description</th>
<th>CONTENT</th>
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</table>
| 4.          | Service and maintain pneumatic conveying systems                             | • Safety requirements  
• Compressors  
• Blowers  
• Feeders  
• Blow pipe  
• Cyclones  
• Bag shakers  
• Precipitators |
| 5.          | Service and maintain roller conveyors and roll cases                         | • Safety requirements  
• Roller wear  
• Alignment  
• Lubrication  
• Drives |
| 6.          | Service and maintain transfer table conveyors                                 | • Safety requirements  
• Chain and belt wear  
• Chain and belt tensioning devices  
• Alignment  
• Lubrication  
• Drives |
| 7.          | Service and maintain monorail conveyors                                      | • Safety requirements  
• Chain and rail wear  
• Chain tensioning devices  
• Alignment  
• Lubrication  
• Drives |
| 8.          | Service and maintain screw conveyors                                         | • Safety requirements  
• Bearings  
• Drives  
• Flights  
• Covers and troughs  
• Lubrication |
Achievement Criteria

Performance The learner will be evaluated on the ability to:
  • Service and repair conveyor components.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Level 4
Millwright
Line (GAC): A WORK PRACTICES
Competency: A5 Use Communication and Teamwork Skills

Objectives
To be competent in this area, the individual must be able to:

- Read and interpret technical reports.
- Organize and participate in group and multi-trade situations and meetings.
- Mentor and guide the training of apprentices to defined industry standards.
- Communicate clearly and effectively in team discussions to plan work, troubleshoot problems and improve safety.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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</thead>
</table>
| 1. Write and interpret technical reports | • Gathering information and data  
  • Interpreting information and data  
  • Service bulletins  
  • Service reports  
  • Update mechanical drawings to reflect as-built (red line) |
| 2. Use oral communication skills required on the job | • Communication skills  
  o Clarity  
  o Concise  
  o Body language  
  o Listening techniques  
  • Safety issues  
  • Participating in a discussion  
  • Mentor apprentices |
| 3. Describe meeting requirements | • Planning and organizing a meeting  
  • Preparing for a meeting  
  • Conducting a meeting  
  • Taking minutes  
  • Participation and discussion  
  • Follow-up |
| 4. Identify and use types of software used in the workplace | • E-mail  
  • Web browser |
| 5. Describe methods for mentoring and guiding the learning of apprentices to defined standards. | • Learning styles  
  • Methods of instruction  
  • Check for understanding  
  • Breaking down a large body of knowledge into smaller learning tasks |
6. Use effective communication techniques. 

- Communication skills
  - Clarity
  - Concise
  - Body Language
  - Listening Techniques
- Safety issues

**Achievement Criteria**

**Performance**
The learner will be evaluated on the ability to:
- Write technical reports
- Organize and participate in group and multi-trade situations and meetings.
- Use effective communication techniques

**Conditions**
As part of practical lab tasks, given the required tools and materials

**Criteria**
Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Objectives
To be competent in this area, the individual must be able to:

- Estimate labour and materials and schedule maintenance work.

LEARNING TASKS

1. Estimate labour requirements
   - Analyze the task
   - Identify amount of work involved
   - Calculate time required

2. Schedule work
   - Plan work activities
   - Coordinate other trades involved
   - Communicate effectively verbally and in writing
   - Interpersonal skills

3. Identify and estimate materials and tools and equipment requirements
   - Read drawings to calculate materials required
   - Identify tools and equipment required
   - Material request forms
   - Coordinate delivery of materials, tools and equipment

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Estimate labour and material requirements
- Schedule work activities
- Schedule maintenance work.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
### Line (GAC): B TRADE SCIENCE

Competency: B7 Describe Theory of Electricity and Electronics

#### Objectives

To be competent in this area, the individual must be able to:

- Explain the basic theories of electricity.
- Identify and explain components in electric and electronic circuits.
- Describe basic safety requirements for working with electrical equipment.

#### LEARNING TASKS

1. Explain the basic theory and principles of electricity and electronics

#### CONTENT

- Theory of electrical principles
  - Atomic theory
  - Voltage
  - Current
  - Conductors
  - Insulators
  - Resistance
  - Schematic circuits
  - Magnets

- Electrical safety
  - Electrical shock
  - Codes
  - Isolation/lockout/tagout
  - Stored energy
  - Fuses
  - Circuit breakers

- Principles of electric circuits
  - Ohms Law
  - Power
  - Inductors
  - Inductance
  - Voltage drops
  - Impedance
Line (GAC): E INSTALL EQUIPMENT
Competency: E6 Describe Procedures for Commissioning Equipment

Objectives
To be competent in this area, the individual must be able to:

- Identify the reports, records and data required for the commissioning and running of equipment.
- Describe the procedures for commissioning and testing running equipment.

LEARNING TASKS

1. Identify reports and other data required for commissioning equipment
   - Blueprints
   - Service manuals
   - Start-up procedures
   - Commissioning report

2. Describe commissioning procedures
   - Review test and trial schedules
   - Check equipment and systems
     - Fuel
     - Lube oil
     - Freedom of movement
     - Electricity
     - Test equipment
     - Air
     - Cooling
   - Perform test and trials
     - Specific performance standards
     - Comparison to specifications
     - Safety/guards/emergency stops
     - Maintenance arrangements
     - Nose levels
     - Defects
   - Identify required changes
     - Sumps
     - Drainage
     - Vibration
     - Pipe hangers
     - Insulation
     - Couplings
   - Report warranty and defects
   - Test results examination
     - Defects
     - Deficiencies
   - Categorize
     - Warranty
     - Design
   - Recommend commissioning improvements
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Apply procedures for commissioning and test running equipment.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): E  INSTALL EQUIPMENT
Competency: E7  Commission Equipment

Objectives
To be competent in this area, the individual must be able to:
• Use the reports, records and data required for the commissioning and running of equipment.
• Commission and test running equipment
• Recommend commissioning improvements where appropriate.

LEARNING TASKS
1. Use reports and other data required to commission equipment
   • Blueprints
   • Service manuals
   • Start-up procedures
   • Commissioning report

2. Perform commissioning procedures
   • Review test and trial schedules
   • Check equipment and systems
     o Fuel
     o Lube oil
     o Freedom of movement
     o Electricity
     o Test equipment
     o Air
     o Cooling
   • Perform test and trials
     o Specific performance standards
     o Comparison to specifications
     o Safety/guards/emergency stops
     o Maintenance arrangements
     o Nose levels
     o Defects
   • Identify and document required changes
     o Sumps
     o Drainage
     o Vibration
     o Pipe hangers
     o Insulation
     o Couplings
   • Report warranty and defects
   • Test results examination
     o Defects
     o Deficiencies
## LEARNING TASKS

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<td>• Categorize</td>
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<td>• Warranty</td>
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<tr>
<td>• Design</td>
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<tr>
<td>• Recommend commissioning improvements</td>
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### Achievement Criteria

**Performance**  The learner will be evaluated on the ability to:

- Use reports, records and data required for the commissioning and running of equipment.

**Conditions**  As part of practical lab tasks, given the required tools and materials

**Criteria**  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): G MAINTAIN PRIME MOVERS
Competency: G1 Explain Prime Mover Theory

Objectives
To be competent in this area, the individual must be able to:

- Explain the relationship between speed, torque and horsepower.
- Describe styles of prime movers based on energy conversion.

LEARNING TASKS
1. Describe prime mover theory

   CONTENT
   - Speed
   - Torque
   - Horsepower
   - Ratios
   - Energy conversion
Program Content
Level 4

Line (GAC): G MAINTAIN PRIME MOVERS

Competency: G2 Describe Electric Motors

Objectives
To be competent in this area, the individual must be able to:

- Describe the basic theory and concepts of electric motor operation.
- Identify types of electric motors used in industrial settings.
- Describe and identify equipment and devices associated with electric motors.
- Describe the selection of the proper electric motor for specific applications.

LEARNING TASKS

1. Describe the basic theory and principles of electric motors
   - Theory of electrical motors
     - Voltage
     - Current
     - Conductors
     - Insulators
     - Resistance
     - Magnets
   - Principles of electric motors
     - Ohms law
     - Power
     - Inductors
     - Inductance
     - Voltage drops
     - Impedance

2. Identify electric motors
   - Capacitor types
   - Series
   - Repulsion start
   - Induction run
   - Single phase
   - Multi phase
   - Squirrel cage
   - Alternating current
   - Direct current

3. Identify associated components
   - Conductors
     - Types
     - Rating
     - Identification
   - Protective devices
     - Fuses
     - Circuit breakers
     - Motor starters
     - Relays
     - Disconnects
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<td>4. Describe the selection of AC and DC motors</td>
<td>• Power requirements</td>
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<td>• Available power</td>
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<td>• Service entrance capacity</td>
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<td>• Mounting bases</td>
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<td>• Overload protection devices</td>
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</table>
Line (GAC): G MAINTAIN PRIME MOVERS
Competency: G3 Maintain Electric Motors

Objectives
To be competent in this area, the individual must be able to:
• Identify and use the tools required to maintain and service electric motors.
• Maintain electric motors and diagnose malfunctions.

LEARNING TASKS
Content

1. Identify and use tools and equipment
   • Volt meter
   • Ammeter
   • Ohmmeter
   • Multimeter
   • Megger

2. Maintain and troubleshoot electric motors
   • Safety requirements
   • Diagnose malfunctions
     o Ground faults
     o Short circuits
     o Overloads
     o Connection
     o Disconnection
     o Overload protection devices
   • Maintenance
     o AC motors
     o DC motors

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Use tools and equipment to service electric motors.
• Maintain and troubleshoot electric motors.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Program Content
Level 4

Line (GAC): G MAINTAIN PRIME MOVERS
Competency: G4 Describe Internal Combustion Engines

Objectives
To be competent in this area, the individual must be able to:

- Describe the operating principles of internal combustion engines.
- Identify components of spark ignition engines and compression ignition engines.

LEARNING TASKS

1. Describe the operation of internal combustion engines

   - Principles of operation
     - Spark ignition
     - Compression ignition
     - Two stroke
     - Four stroke
   - Function of
     - Air
     - Fuel
     - Ignition
     - Reciprocating to rotary motion
     - Compression

2. Describe spark ignition motor components

   - Fuel system
   - Ignition system
   - Motor components
     - Valves
     - Pistons
     - Cylinders
     - Crank shafts
     - Motor blocks
     - Exhaust mechanisms

3. Describe compression ignition motor components

   - Fuel system
   - Ignition system
     - Valves
     - Pistons
     - Cylinders
     - Crank shafts
     - Motor blocks
     - Air intake mechanisms
     - Exhaust mechanisms
     - Filters (air and fuel)
Program Content
Level 4

Line (GAC): G MAINTAIN PRIME MOVERS
Competency: G5 Describe the Maintenance of Internal Combustion Engines

Objectives
To be competent in this area, the individual must be able to:

- Identify the tools required to maintain and service internal combustion engines.
- Describe the maintenance and diagnosis of internal combustion engines.

### LEARNING TASKS

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<td>- Tachometers</td>
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<td>- Timing lights</td>
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<tr>
<td>- Compression testers</td>
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<tr>
<td>- Electric load testers</td>
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<tr>
<td>- Electronic test equipment</td>
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<tr>
<td>2. Describe maintenance and troubleshooting of internal combustion engines</td>
</tr>
<tr>
<td>- Safety requirements</td>
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<tr>
<td>- Procedures</td>
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<td>- Fuel system</td>
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<td>- Ignition system</td>
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<td>- Compression</td>
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<td>- Exhaust</td>
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</table>
Program Content
Level 4

Line (GAC): G MAINTAIN PRIME MOVERS
Competency: G6 Describe Turbines

Objectives
To be competent in this area, the individual must be able to:

• Describe the operating principles of turbines.
• Describe components of steam, gas and hydro turbines.

LEARNING TASKS

1. Describe the operating principles of turbines

   • Turbine theory
     o Impulse
     o Reaction
     o Combination
   • Gas turbines
   • Hydro turbines
   • Steam turbines
   • Wind turbines
   • Co-generation

2. Identify and describe turbine components

   • Steam turbines
     o Valves
     o Nozzles
     o Buckets
     o Shaft
     o Seals
     o Governors
     o Blades
     o Bearings
     o Rotors
     o Speed controls
     o Positioning devices
   • Gas turbines
     o Compressors
     o Combustors
     o Turbine/rotor
     o Fuel
   • Hydro turbines
     o Runners
     o Control mechanisms
     o Pen stocks
Line (GAC): G MAINTAIN PRIME MOVERS
Competency: G7 Describe the Maintenance of Turbines

Objectives
To be competent in this area, the individual must be able to:

• Identify the tools required to maintain and service turbines.
• Describe the maintenance and diagnosis of turbines.

LEARNING TASKS

1. Identify and use tools and equipment
   • Vibration meters
   • Tachometers
   • Boroscopes
   • Non-destructive testing equipment

2. Describe maintenance and diagnosis of turbines
   • Safety requirements
   • Operation
     o Start-up
     o Safety mechanisms
     o Governors
     o Shutdown
   • Procedures
     o Fuel system
     o Ignition system
     o Inspection
     o Routine maintenance
     o Lubrication
     o Speed checks
     o Vibration
     o Safety
     o Lock out
     o Troubleshooting
     o Seal maintenance
**Line (GAC):**  G  **MAINTAIN PRIME MOVERS**  
**Competency:**  G8  **Describe Power Turbines**

**Objectives**
To be competent in this area, the individual must be able to:

- Describe methods of operation and the theory of turbine power units.
- Identify the components associated with turbine power units.
- Describe maintenance and service procedures for turbine power units.

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>LEARNING TASK</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe the operation and theory of turbine power units | - Theory  
  o Compressed gas laws  
- Types  
  o Reaction  
  o Impulse  
- Methods of operation |
| 2. Identify and describe components of turbine power units | - Intake systems  
  o Plenums  
  o Filters  
- Exhaust systems  
- Components  
  o Rotor  
  o Blades  
  o Bearings  
  o Lubrication systems  
  o Speed control |
| 3. Describe procedure to maintain and service turbine power units | - Safety requirements  
- Inspection procedures  
  o External examinations  
  o Alignment  
  – Noise  
  – Vibration  
  – Speed  
  – Lubrication  
  o Internal inspections  
  – Wear patterns  
  – Vanes  
  – Bearings |
Line (GAC): I SERVICE FLUID POWER
Competency: I6 Explain Pneumatic Theory

Objectives
To be competent in this area, the individual must be able to:

- Explain terms associated with pneumatic systems.
- Explain the application of gas laws associated with pneumatics.

LEARNING TASKS
1. Describe the theory of compressed gasses

CONTENT
- Terms and Laws
  - Pascal’s Law
  - Boyle’s Law
  - Charles’ Law
  - Torricelli’s Principle
  - Vacuum and pressure scales
  - Temperature scales
  - Atmospheric pressure
  - Heat of compression
  - Flow rate
- Energy transmission
  - Heat energy
  - Pressure energy
- Air compression
  - Adiabatic
  - Isothermal
Line (GAC):  I  SERVICE FLUID POWER
Competency:  I7  Describe Pneumatic Components

Objectives
To be competent in this area, the individual must be able to:

- Describe fluid conductors, fittings and their application.
- Describe pneumatic valves and their application.
- Describe filter, regulator and lubricator units.
- Describe actuators and their application.
- Describe dryers.

LEARNING TASKS
1. Describe fluid conductors

CONTENT
- Piping
  - Terminology
    - Pipe diameter
    - Rate of flow
    - Turbulence
    - Friction
    - Wall thickness
    - Bursting pressure
    - Safety factors
  - Types
  - Thread and seal types

- Tube
  - Types
    - Carbon steel
    - Stainless steel
    - Copper
    - Aluminum
    - Plastic
  - Installation
  - Measuring
  - Bending ratio
  - Fittings

- Hose
  - Parts
  - Types
  - Pressure rating
  - Fittings
  - Installation
LEARNING TASKS

2. Describe valves

- Valve functions
  - Starting flow
  - Stopping flow
  - Preventing back flow
  - Regulating pressure
  - Relieving pressure
- Valve types
  - Gate
  - Glove
  - Check
  - Plug
  - Diaphragm
  - Needle
  - Butterfly
  - Safety
  - Relief
  - Regulator
  - Time delay
  - Quick exhaust
  - And valve
  - Or valve
  - Directional control
  - Pressure regulators
- Maintenance and installation
  - Requirements for joints
  - Packing requirements
  - Diagnosis

3. Describe filters/separators

- Function
- Differences from strainers
- Types specifications
- Ratings
- Locations
- Procedures for maintaining
- Air/oil separators

4. Describe lubricators

- Types and specifications
- Operation
- Construction
- Service procedures
5. Describe actuators

- Linear actuators
  - Parts
  - Classification
  - Construction
  - Seals
  - Variations
  - Sizing
  - Mounting procedures

- Rotary actuators
  - Parts
  - Construction
  - Seals
  - Variations

6. Describe dryers

- Terminology
  - Relative humidity
  - Absolute humidity
  - Dew point
  - Effects of temperature of humidity
  - Use of refrigerant for drying

- Types of driers
  - Desiccant
  - Refrigeration
Line (GAC): I SERVICE FLUID POWER
Competency: I8 Interpret Pneumatic Schematics

Objectives
To be competent in this area, the individual must be able to:

- Identify and use schematic and graphical symbols used in pneumatic circuitry as it pertains to JIC and ISO standards.

LEARNING TASKS
1. Identify and use pneumatic schematic symbols
2. Interpret and troubleshoot pneumatic circuits

CONTENT
- Standard graphic symbols
  - JIC (ANSI)
  - ISO
- Design principles
- Circuit layout
- Numbering systems
- Single acting cylinder circuits
- Double acting cylinder circuits
- Time-delay
- Sequential control
- Manufacturer’s service manuals
- Maintain circuit records
Line (GAC): I SERVICE FLUID POWER
Competency: I9 Identify Pneumatic Pumps

Objectives
To be competent in this area, the individual must be able to:

• Identify the styles and application of pneumatic pumps (compressors).

LEARNING TASKS CONTENT
1. Identify pneumatic pumps (compressors)
   - Identification
     o Positive
     o Non-positive
     o Reciprocating
     o Rotary
     o Vacuum
   - Operation
     o Single acting
     o Double acting
     o Single stage
     o Multi stage
Line (GAC): I SERVICE FLUID POWER
Competency: I10 Assemble, Maintain and Troubleshoot Pneumatic Circuits

Objectives
To be competent in this area, the individual must be able to:

- Interpret and design pneumatic circuitry.
- Assemble basic pneumatic circuitry.
- Maintain and service pneumatic systems and circuits.
- Diagnose faults associated with pneumatic circuits.
- Set and adjust pneumatic circuits.

LEARNING TASKS

1. Design pneumatic circuits and schematic diagrams
   - Diagrams
     - Types
     - Components
     - Symbols
     - Schematics

2. Assemble pneumatic circuits
   - Types
     - Linear
     - Rotary
     - Speed control
     - Reduced pressure
     - Sequence
     - Time delay

3. Maintain and troubleshoot pneumatic circuits
   - Safety requirements
   - Service procedures
   - Maintenance and installation procedures
   - Troubleshooting

4. Install and maintain filters
   - Function
   - Differences from strainers
   - Types specifications
   - Ratings
   - Locations
   - Procedures for maintaining

5. Install and maintain lubricators
   - Types specifications
   - Operation
   - Construction
   - Service procedures

6. Install and maintain regulators
   - Types specifications
   - Operation
   - Construction
   - Service procedures
LEARNING TASKS

7. Install and maintain actuators

CONTENT

• Linear actuators
  o Parts
  o Classification
  o Construction
  o Seals
  o Variations
  o Sizing
  o Mounting procedures
• Rotary actuators
  o Parts
  o Construction
  o Seals
  o Variations

8. Describe the maintenance of dryers

CONTENT

• Terminology
  o Relative humidity
  o Absolute humidity
  o Dew point
  o Effects of temperature of humidity
  o Use of refrigerant for drying
• Types of driers
  o Desiccant
  o Refrigeration

Achievement Criteria

Performance The learner will be evaluated on the ability to:
  • Design pneumatic circuits and schematic diagrams
  • Assemble pneumatic circuits
  • Maintain and troubleshoot pneumatic circuits
  • Install and maintain filters, lubricators, actuators and regulators

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
LINE (GAC):  I  SERVICE FLUID POWER

Competency:  I11  Explain the Theory of Vacuum and Vacuum Systems

Objectives
To be competent in this area, the individual must be able to:

- Explain the theories and principles of vacuum systems.

**LEARNING TASKS**

1. Describe the principles of vacuum

**CONTENT**

- Terminology
  - Vacuum
  - Negative pressure
  - Atmospheric pressure
  - Suction
- Laws and Principles
  - Pascal’s Law
  - Bernoulli’s Principle
  - Ideal gas laws
  - Calculations
Line (GAC): I SERVICE FLUID POWER
Competency: I12 Interpret Vacuum Symbols

Objectives
To be competent in this area, the individual must be able to:

- Identify and interpret the symbols used on vacuum system drawings.

LEARNING TASKS
1. Identify the symbols associated with vacuum systems and interpret their meaning
   - ISO
   - JIC (ANSI)
Line (GAC): I SERVICE FLUID POWER
Competency: I13 Identify Vacuum System Components

Objectives
To be competent in this area, the individual must be able to:

- Identify vacuum system components.

LEARNING TASKS

1. Identify components associated with vacuum systems

CONTENT

- Conductors
  - Tube
  - Hose
  - Pipe
  - Ducting
- Valves
  - Pressure actuated
  - Directional control
  - Load control
  - Pressure regulation
  - Shut-off
- Pumps
  - Positive
  - Non-positive
Line (GAC):  I SERVICE FLUID POWER
Competency:  I14 Describe Vacuum Systems

Objectives
To be competent in this area, the individual must be able to:

• Describe types of vacuum circuits found in industrial settings.

LEARNING TASKS

1. Identify and describe the types of vacuum circuits found in industry

CONTENT

• Types of vacuum circuit
  o Production
  o Manufacturing
  o Packaging
Line (GAC): I SERVICE FLUID POWER
Competency: I15 Maintain and Troubleshoot Vacuum Systems

Objectives
To be competent in this area, the individual must be able to:

- Service and maintain vacuum systems.

LEARNING TASKS

1. Maintain vacuum systems and diagnose problems

   CONTENT
   - Safety requirements
   - Read schematic drawings
   - Identify faults
   - Use service manuals
   - Determine maintenance requirements
   - Adjust and regulate systems

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Maintain and troubleshoot vacuum systems.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): J SERVICE COMPRESSORS
Competency: J1 Explain Compressor Theory

Objectives
To be competent in this area, the individual must be able to:

- Explain the laws and principles that apply to compressor operation.

**LEARNING TASKS**

1. Explain the application of compressor theory

**CONTENT**

- Gas laws
- Compressor operation
- Compression ratios
Program Content
Level 4

Line (GAC): J  SERVICE COMPRESSORS
Competency: J2 Identify and Describe Types of Compressors

Objectives
To be competent in this area, the individual must be able to:

- Identify compressors by their application.
- Identify types and styles of positive and non-positive compressors.
- Explain the principles of operation of positive displacement compressors.
- Explain the principles of operation of non-positive displacement compressors.

LEARNING TASKS

1. Describe the application of compressors in industrial settings

- Industries
  - Oil
  - Gas
  - Refrigeration
  - Air conditioning
  - Instrument air
  - Mining
  - Pulp and paper
  - Wood manufacturing
  - Miscellaneous manufacturing industries

2. Describe the major classifications of compressors

- Positive displacement
- Non-positive displacement

3. Identify types and styles of compressors

- Reciprocating
  - Piston
  - Free piston
  - Diaphragm
  - Cross-head
  - Trunk
- Rotary
  - Vane
  - Screw
  - Lobe
- Dynamic
  - Centrifugal
  - Axial

4. Describe positive displacement compressor theory

- Describe the operating principles of positive displacement compressors
  - Safety requirements
  - Compression ratios
  - Energy requirements
  - Use in industry
LEARNING TASKS

5. Describe non-positive displacement compressor theory

CONTENT

- Describe the operating principles of non-positive displacement compressors
  - Safety requirements
  - Air flow
  - Air movement
  - Use in industry
Line (GAC): J  SERVICE COMPRESSORS
Competency: J3  Service Compressors

Objectives
To be competent in this area, the individual must be able to:

- Service, troubleshoot and maintain compressors.

LEARNING TASKS

1. Service and maintain compressors according to manufacturer’s specifications
   - Safety requirements
   - Read service manuals
   - Maintenance checks
     - Vibration
     - Alignment
     - Wear
     - Noise

2. Troubleshoot common compressor problems
   - Read service manuals

CONTENT

Achievement Criteria

Performance  The learner will be evaluated on the ability to:
   - Service, troubleshoot and maintain compressors.

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Line (GAC): M OPERATIONAL EQUIPMENT EFFECTIVENESS
Competency: M1 Describe Operational Equipment Effectiveness Processes

Objectives
To be competent in this area, the individual must be able to:

• Describe the processes used to interpret and record equipment history.
• Create problem solving flow charts to plan equipment maintenance procedures.
• Explain the importance of maintenance planning.
• Describe the theory behind priority maintenance scheduling.
• Describe types of maintenance procedures.

LEARNING TASKS

1. Describe equipment maintenance history records
   - Computerized maintenance record keeping systems
   - Identify system and equipment problems

2. Describe procedures used to analyze equipment data
   - Interpret data to determine appropriate maintenance requirements
   - Determine suitable maintenance schedules

3. Create problem solving flow charts
   - List the information required to create a flow chart
     - Safety audit of equipment
     - Production and operation schedules
     - Spare parts inventory
     - Record information for future use
     - Labour requirements
     - Time scheduling
   - Create a maintenance schedule
     - Comprehend maintenance planning programs
       - Critical path method (CPM)
       - Program evaluation review techniques (PERT)
LEARNING TASKS

4. Describe theory of maintenance procedures

CONTENT

- Describe maintenance inspections
  - Purpose
    - Prevention of problems
    - Predictive maintenance
  - Procedures
    - What to inspect
    - When to inspect
    - Who inspects
    - Record maintenance
  - Applicable safety requirements

- Describe the theory of priority maintenance scheduling
  - Maintenance pyramid
    - Critical
    - Important
    - Non-threatening
    - Recoverable failures

5. Describe types of maintenance

CONTENT

- Describe maintenance procedures
  - Breakdown maintenance
  - Predictive maintenance (PDM)
    - Computerization of records keeping (CMMS)
  - Preventative maintenance (PM)
Line (GAC): M OPERATIONAL EQUIPMENT EFFECTIVENESS
Competency: M2 Describe Use of Predictive Maintenance Tools

Objectives
To be competent in this area, the individual must be able to:

- Identify the tools associated with predictive maintenance.
- Describe methods of testing for predictive maintenance.

LEARNING TASKS CONTENT

1. Describe the methods of non-destructive testing

- Dye penetration
  - Types
  - Limitations
- Ultrasonic testing
  - Applications
  - Advantages and disadvantages
  - Level of certification required
- Radiography testing
  - Applications
  - Advantages and disadvantages
  - Safety requirements
  - Types of equipment
  - Level F certification required
- Vibration analysis
  - Application
  - Advantages and disadvantages
  - Terminology
    - Amplitude
    - Frequency
    - Natural frequency
    - Resonance
    - Critical speed
    - Harmonic
  - Equipment
    - Reeds lights beam vibration indicators
    - Battery operated meters
- Mechanical particle testing
  - Application
  - Advantages and disadvantages
  - Methods of use
  - Limitations
  - Type of defects located
  - Equipment required
- Infrared testing
  - Application
  - Equipment
  - Advantages and disadvantages
  - Limitations
LEARNING TASKS

CONTENT

- Balance testing
  - Application
  - Equipment
  - Static dynamic
  - Safety considerations

- Visual testing
  - Application
  - Equipment
  - Advantages and disadvantages

- Temperature monitoring equipment
  - Temperature probes
  - Thermo graphic equipment

- Analyzer fluids
  - Ferrography
  - Spectrography
  - Viscosity
  - Particle count
  - Filter patch
Line (GAC): M OPERATIONAL EQUIPMENT EFFECTIVENESS
Competency: M3 Identify Equipment and Process Deficiencies

Objectives
To be competent in this area, the individual must be able to:

• Interpret information to remedy equipment and process deficiencies.

LEARNING TASKS
1. Describe the steps for diagnosis of equipment deficiencies

CONTENT
• Know machine
• Read schematic
• Read service manuals
• Talk to operator
• List possible causes
• Reach conclusion
• Test conclusion
Line (GAC): M OPERATIONAL EQUIPMENT EFFECTIVENESS
Competency: M4 Perform Vibration Analysis and Rotating Equipment Balancing

Objectives
To be competent in this area, the individual must be able to:

- Perform vibration analysis.
- Balance rotating equipment.

LEARNING TASKS

1. Describe and use vibration analysis procedures

 CONTENT
- Safety
- Vibration theory and characteristics
- Types of analyzers and applications
- Manufacturer’s specifications
- Vibration noise measurement
- Vibration frequencies
  - Journal and rolling element bearings
  - Mechanical looseness
  - Rubbing
  - Excessive lubrication
  - Gears
  - Belts
  - Cavitation
- Equipment selection
- Transducer installation
- Causes of vibration
  - Corrosion
  - Wear
  - Eccentricity
  - Shaft problems
  - Misalignment
  - Distortion

2. Analyze vibration test data

 CONTENT
- Test equipment
- Data recording systems
- Scheduling procedures
- Vibration limits and tolerances
  - Manufacturer’s specifications
- Equipment data download procedures
- Alarm thresholds
LEARNING TASKS

3. Describe and perform equipment balancing

CONTENT

- IPT rotating equipment handbook
- Safety
- Pre-balance procedures and requirements
- Balancing methods
- Formula calculations
- Unbalance recognition
- Static and dynamic balancing procedures
- Single and multi-plane balancing procedures
- ISO standards

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Perform vibration analysis
- Perform equipment balancing.

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry.
Section 4

TRAINING PROVIDER STANDARDS
Training Provider Standards

Facility Requirements

Classroom Area
- 1,000 sq. ft. for a class size of 16 students, with moveable tables and chairs
- Instructional media to include multimedia projector, projection screen, DVD player, and whiteboard

Indoor Shop Area
- 200 sq. ft. per student
- Well heated and ventilated
- 20 ft. high ceilings
- Lighting appropriate to detailed work

Instructor’s Office Space
- 150 sq. ft. per instructor, with a desk, chairs and materials storage/filing system

Storage
- 100 sq. ft. per student for storage of materials (may be outdoors)
- 25 sq. ft. per student for tools storage
- 15 sq. ft. per student for individual project and materials storage
Tools and Equipment

Hand Tools
- Bench vise
- Breaker bar
- Broaches
- Burrs
- Calculator
- C-clamp
- Chemical locking products
- Chisel
- Dies
- Files
- Hammers
  - Ball peen
  - Claw
  - Mallet
  - Shaping
  - Sledge
  - Soft faces mallet
- Helicoil
- Hone
- Machinist clamp
- Mechanical lubricators
- Packing pullers
- Pliers
  - Angle cutters
  - Linesman
  - Locking
  - Needle nose
  - Side cutters
  - Slip joint
  - Snap ring
  - Water pump
- Pullers (3 leg, 2 leg)
- Reamers
- Riveting tools
- Rod (guillotine) puller
- Rotary files
- Saws
  - Hacksaws
  - Hand saw (wood)
  - Rod saws
- Scappers
- Screw drivers
- Shears
- Slide hammer puller
- Snips
- Taps
- Thread chasers
- Thread files
- Threading machine
- Tool & die clamp
- Torque wrenches
  - Hydraulic
  - Pneumatic
- Vices
  - Machine tool
  - Machinist
  - Rotary
  - Tool & die
  - Universal
- Wrenches
  (metric/imperial)
  - Adjustable
  - Allen
  - Box end
  - Chain
  - Combination
  - Crows foot
  - Hook spanner
  - Open end
  - Pin spanner
  - Pipe
  - Slug
  - Strap
  - Socket
  - Speed
- Pullers (3 leg, 2 leg)
- Reamers
- Riveting tools
- Rod (guillotine) puller
- Rotary files
- Saws
  - Hacksaws
  - Hand saw (wood)
  - Rod saws
- Scappers
- Screw drivers
- Shears
- Slide hammer puller
- Snips
- Taps
- Thread chasers
- Thread files
- Threading machine
- Tool & die clamp
- Torque wrenches
  - Hydraulic
  - Pneumatic
- Vices
  - Machine tool
  - Machinist
  - Rotary
  - Tool & die
  - Universal
- Wrenches
  (metric/imperial)
  - Adjustable
  - Allen
  - Box end
  - Chain
  - Combination
  - Crows foot
  - Hook spanner
  - Open end
  - Pin spanner
  - Pipe
  - Slug
  - Strap
  - Socket
  - Speed

Power Hand Tools
- Angle grinder
- Chain saw
- Circular saw
- Cut-off saws
- Die grinder
- Drill bits
- Drill motors
- Electric wrenches
- Hydraulic wrenches
- Key seat cutter
- Pneumatic wrenches
- Portable milling machine
- Portable roll grinder
- Portable threaded
- Powder actuated guns
- Power hack saw
- Reciprocating saw
- Rotary burrs
- Rotary files
- Rotary impact drills
- Specialty grinder
Measuring and Layout Tools

- Adjustable square
- Angle gauge
- Angle plate
- Ball gauge
- Bench marks
- Bevel protractor
- Builder’s level (dummy)
- Combination set
- Computer alignment equip.
- Concentricity bench
- Datum plates & marks
- Depth micrometer
- Dial bore gauge
- Dial indicator
- Dividers
- Feeler gauges
- Flat bottom gauge
- Framing square
- Gauge blocks
- Gauges
- Go-no-go gauge
- Grease guns
- Hermaphrodite calliper
- Hole gauges
- Inside callipers
- Inside micrometer
- Inspection square
- Installation prints
- Intramiks
- Jigs
- Laser alignment equip
- Laser level
- Rotary laser level
- Layout solutions
- Layout table
- Machinist level
- Machinist square
- Magnetic bases
- Measuring tape (metric/imperial)
- Optical level
- Outside callipers
- Outside micrometer
- Parallels
- Piano wire
- Plumb bobs
- Prick punches
- Center punches
- Protractors
- Radius gauges
- Rules
- Scribes
- Shim gauges
- Sighting plate
- Sine bar
- Sine plate
- Sliding parallels
- Spirit level
- Straight edges
- Surface plate
- Taper gauge
- Telescope gauge
- Theodolites
- Thread gauges
- Thread micrometer
- Tram plates
- Trammels
- Transits
- Universal bevel protractor
- V-blocks
- Vernier calliper
- Vernier height gauge
- Wire gauge

Stationary Shop Tools

- Bench grinder (6 in.)
- Gear head drill press (MT#3)
- Horizontal band saw
- Horizontal milling machine
- Hydraulic press
- Indexing head
- Lathe (10 in. swing)
- Milling cutters
- Pedestal grinder
- Radial arm drill press (MT#3)
- Sensitive drill press (MT#2)
- Tool grinder
- Tool post grinder
- Universal radial arm drill press (MT#3)
- Vertical band saw
- Vertical milling machine
- Welding equipment
- Oxy-acetylene
- Shielded metal arc
- Gas metal arc
Testing Equipment

- Balancing equipment
- Boroscope
- Refractometer
- Compression tester
- Computer maintenance software
- Data collectors
- Destructive testers
- Electric load tester
- Hardness tester
- Heat treatment oven
- Impact tester
- Insulation tester
- Magnaflux equipment
- Multi-meters
- Non-destructive testing
- Ohmmeter
- Oscilloscope
- Tachometer
- Tensile tester
- Timing light / strobe
- Transducers
- Ultra sonic tester
- Vibration analysis equipment
- Vibration meters

Lifting Equipment

- Blocks and tackles
- Boom lift
- Boom trucks crane
- Bridles
- Chain hoists
- Come-a-longs
- End terminations
- Engine hoist/cherrypicker
- Eye bolts
- Fibre rope
- Fibre slings
- Forklift
- Hand winches
- Hoist rings
- Hooks
- Jacks
- Ladders
- Mobile crane/gantry frame
- Overhead travel crane
- Pulleys
- Scaffolding
- Shackles
- Spreader bar
- Tifors
- Turn buckles
- Wire rope
- Wire slings

Personal Protective Equipment

- Air testing equipment
- Coveralls
- Ear muffs
- Ear plugs
- Electrical gloves
- Face shield
- Fall arrest
- Fitters gloves
- Fluorescent vest
- Glasses
- Goggles
- Hard hats
- Insulated gloves
- Lock out equipment
- Respirators
- Safety footwear
- Testing equipment
  - Sniffers
  - Gas analyzers
- Welding gloves
Training Provider Standards

Training Equipment and Supplies

- Mechanical seals
  - Lapping equipment
- Packing
- Seals
- Anti-friction bearings
- Friction bearings
- Couplings
  - Rigid
  - Flexible
  - Universal joint
  - Centrifugal
  - Brake coupling
- Gears
  - Spur
  - Helical
  - Worm & wheel
  - Hypoid
  - Bevel
  - Reduction units
- Belts
  - Flat
  - V-belts
  - Timing
  - Power band
  - Tension gauge
  - Sheave & belt gauge
  - Sheaves
  - Variable speed reducer/increaser
- Clutches & brakes
  - Pneumatic
  - Hydraulic
  - Electric
  - Manual
  - Positive
  - Friction
  - Centrifugal
- Transmission chain
  - Roller
  - Engineered
  - Silent
  - Inverted tooth
  - Sprockets
  - Reducers
- Turbine reaction reducers
- Hydraulics
  - Pressure gauge
  - Flow gauge
  - Temperature gauge
  - Filters
  - Directional control valves
  - Pressure actuated valve
  - Fluid conductors
  - Actuators
  - Intensifiers
  - Pumps
  - Reservoirs
  - Accumulators
  - Circuit boards
- Pneumatics
  - Conductors
  - Directional control valves
  - Pressure relief valves
  - F-R-L units
  - Compressors/pumps
  - Actuators
  - Receivers
  - Dryers
  - Circuit boards
- Prime movers
  - Electric motors
    - AC motors
    - DC motors
  - Internal combustion engines
    - Compression ignition engines
  - Spark ignition engines
  - Turbines
    - Steam turbine
    - Gas turbine
    - Hydraulic turbine
- Vacuum systems
  - Vacuum pumps
  - Valves
  - Actuators
  - Filters
  - Compressors
  - Positive displacement
  - Non-positive displacement
  - Gauges
- Pumps
  - Positive displacement
  - Non-positive displacement
Training Provider Standards

Information Materials

Blueprints
- Plats
- Site plans
- Building (structural)
- Electrical
- Piping
- Equipment
- Installation
- Assembly
- Engineering (fabrication)

Catalogues
- Hazardous material signs
- MSDS
- Service manuals
- WHMIS
- IPT handbooks (strongly recommended)
  - rotating equipment
  - safety
  - rigging
  - hydraulics
  - industrial fasteners and fittings
  - power transmissions
Instructor Requirements

Occupation Qualification
The instructor must possess:

- Millwright – Certificate of Qualification with Interprovincial Red Seal endorsement, plus
- 5 years of hands-on working experience as a Millwright after earning Interprovincial Red Seal certification

Instructional Experience and Education
It is preferred that the instructor also possesses one of the following:

- Provincial (BC) Instructor Diploma or completion of a similar Trainer Training / Instructional Methods program, plus
- 2 years of instructional experience
Appendices
Appendix A – Glossary of Acronyms

Adjust: To bring to a more satisfactory state. To bring the parts of to a true or more effective relative position.

Align: To bring into alignment.

Analyze: To examine critically so as to determine appropriate procedures, process, or course of action.

Apply: To put to use especially for some practical purpose.

Assemble: To fit together the parts of.

Assess: To determine the value, significance, or extent of; appraise.

Calculate: To arrive at a precise numerical answer – often through the use of mathematical formulas.

Construct: To make or form by combining or arranging parts or elements.

Define: To set forth the meaning of a word or expression.

Demonstrate: To exhibit, show clearly or perform, to a competency standard, a process or competence.

Describe: To set forth the properties or characteristics of an object. To give a detailed or graphic account of a process or procedure. (To use correct terminology, sequencing and inter-relationship of the elements is implied where required.)

Determine: To arrive at, or locate, information by a simple process (e.g. by rule of thumb).

Explain: To show the logical development or relationships of.

Evaluate: To determine the significance, worth, or condition of usually by careful appraisal and study.

Identify: To use the correct terminology to describe objects, both individually and collectively; to state their application or use, and to point out and name them.

Inspect: To look into, or at carefully. To examine, or observe, critically in order to detect flaws, errors, etc.

Install: To set up for use or service.

List: To give in point form, several items of information; no sequence or inter-relationship is implied.

Locate: To seek out and determine the location of.

Maintain: To keep in good condition. To keep functional, and in good repair.

Obtain: To gain or attain usually by planned action or effort.

Operate: To perform a function: exert power or influence.

Overhaul: To check thoroughly for needed service, and to make the repairs, replacements, adjustments, etc., necessary to restore to good working order.

Perform: To carry out. To do in a formal manner or according to prescribed ritual.

Rebuild: To restore to an original state.

Remove: To move by lifting, pushing aside, or taking away or off.

Repair: To put back into good condition after damage or wear. To mend or fix.

Replace: To put something new in the place of.

Select: To choose the most appropriate object, process or procedures, given a specific situation; (when used in relation to an object it also implies the ability to identify and describe).

Service: To remove, maintain, repair, or replace items and/or components.
Appendix A
Glossary of Acronyms

Set up: To assemble the parts of and erect in position.
Sketch: To make a sketch, rough draft, or outline of.
State: To set out briefly (in the equivalent of a sentence or two) an idea.
Test: To try something against a criterion or standard.
Troubleshoot: To investigate a problem. To look at, or into, critically and methodically in order to find out the causes, facts, conditions, etc.
Use: The act or practice of employing something
Appendix B

Assessment Guidelines
Appendix B – Assessment Guidelines

Program: Industrial Mechanic (Millwright)

Training providers delivering Industrial Mechanic (Millwright) apprenticeship in-school technical training are required to enter the following information in ITA Direct Access for each apprentice:

- An in-school mark in the form of a percentage (Minimum 70% is required for a pass)

Training Provider Component: In-School Technical Training

The in-school mark for each level is derived from a combination of theory and practical assessments. This mark is then combined with the ITA Standard Level Examination to determine a final mark for the level.

Calculation tables showing the subject competencies, level percentage weightings and level examination weightings are shown in the Grading Sheet: “Subject Competencies and Weightings” section of this document.

Industrial Mechanic (Millwright) Level 1, 2 & 3 in-school marks are calculated by:

- Totaling the level theory competency results as noted in the competencies and weightings tables and multiplying the total by 75% for Level 1, 2 & 3 to produce a weighted theory result;
- Totaling the level practical competency results as noted in the competencies and weightings tables and multiplying the total by 25% for Level 1, 2, & 3 to produce a weighted practical result;
- Adding the theory and practical competency results together to determine the final in-school result.

Successful completion of the in-school training for each level is defined as an in-school mark of 70% or greater.

ITA Component: ITA Standardized Level Examinations - Level 1, 2 & 3

ITA Direct Access (ITADA) automatically calculates the final mark for a level once the in-school training and standard level exam marks are entered into the system. This mark is calculated by blending the standardized exam percentage score and the in-school technical training percentage score to determine the final mark for the level.

In-school technical training (combined theory & practical) is weighted at 80% and the ITA standardized exam is weighted at 20%. These two scores are combined to determine the final level mark. This result is recorded in ITA Direct Access.

- A mark of 70% or greater is required to pass the level when combining the final in-school percentage score and the final ITA standardized level exam percentage score.
Level 4 - Proprietary Examinations

Until further notice, Training Providers delivering the Industrial Mechanic (Millwright) program will continue using their institution’s proprietary examination in the calculation of the apprentices’ achievement for Level 4. The percentage weighting of this exam is 25% of the final in-school technical training mark.

Refer to the Grading Sheet Subject Competencies and Weightings Level 4 Table to determine the calculation process for completing a final Level 4 percentage. The final blended mark for Level 4 is to be reported to ITA and must be 70% or greater to pass the level.

Interprovincial Red Seal Exam

In order to achieve certification, Industrial Mechanic (Millwright) apprentices are required to write the Industrial Mechanic (Millwright) Interprovincial Red Seal exam after completing all levels of in-school technical training. Apprentices must have passed all levels of in-school technical training or be approved challengers to sit the exam. A score of 70% or greater is required for a pass.

Interprovincial Red Seal exams should be requested by training providers via the usual ITA procedure. The ITA will administer and invigilate Interprovincial Red Seal exams and score and record exam results in ITA Direct Access.
### Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>LINE</th>
<th>TRAINING TOPICS &amp; SUGGESTED TIME ALLOCATION</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Work Practices</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>Trade Science</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>C</td>
<td>Use Tools</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>F</td>
<td>Cut, Fit &amp; Fabricate</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

In-school theory / practical subject competency weighting

- **75%**
- **25%**

Final in-school percentage score

- **IN-SCHOOL %**

### In-school Percentage Score

Combined theory and practical subject competency multiplied by **80%**

### Standard Level Exam Percentage Score

The exam score is multiplied by **20%**

### Final Percentage Score

**FINAL%**
### PROGRAM:
IN-SCHOOL TRAINING:
ITADIRECTACCESS CODE:
INDUSTRIAL MECHANIC (MILLWRIGHT)
LEVEL 2
0015MW

<table>
<thead>
<tr>
<th>LINE</th>
<th>TRAINING TOPICS &amp; SUGGESTED TIME ALLOCATION</th>
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<th>PRACTICAL WEIGHTING</th>
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<tr>
<td>B</td>
<td>Trade Science</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td>D</td>
<td>Lubricants, Seals &amp; Bearings</td>
<td>17%</td>
<td>25%</td>
</tr>
<tr>
<td>E</td>
<td>Install Equipment</td>
<td>17%</td>
<td>25%</td>
</tr>
<tr>
<td>F</td>
<td>Cut, Fit &amp; Fabricate</td>
<td>16%</td>
<td>0%</td>
</tr>
<tr>
<td>H</td>
<td>Service Power Transmission</td>
<td>16%</td>
<td>25%</td>
</tr>
<tr>
<td>I</td>
<td>Service Fluid Power</td>
<td>17%</td>
<td>25%</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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</table>

In-school theory / practical subject competency weighting

<table>
<thead>
<tr>
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<th>25%</th>
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Final in-school percentage score

<table>
<thead>
<tr>
<th>Final in-school percentage score</th>
<th>IN-SCHOOL %</th>
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</thead>
</table>

**In-school Percentage Score**
Combined theory and practical subject competency multiplied by 80%

**Standard Level Exam Percentage Score**
The exam score is multiplied by 20%

**Final Percentage Score**
FINAL%
## Program: Industrial Mechanic (Millwright) Industry Training Authority 19109/15

### Level 3

#### 0015MW

<table>
<thead>
<tr>
<th>LINE</th>
<th>Training Topics &amp; Suggested Time Allocation</th>
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<tbody>
<tr>
<td>E</td>
<td>Install Equipment</td>
<td>20%</td>
<td>20%</td>
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<tr>
<td>H</td>
<td>Service Power Transmission</td>
<td>20%</td>
<td>20%</td>
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<tr>
<td>I</td>
<td>Service Fluid Power</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>K</td>
<td>Service Pumps</td>
<td>20%</td>
<td>20%</td>
</tr>
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<td>L</td>
<td>Service Material Handling Systems</td>
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<td>20%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
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**In-school theory / practical subject competency weighting**

<table>
<thead>
<tr>
<th></th>
<th>Theory</th>
<th>Practical</th>
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<tbody>
<tr>
<td><strong>Total</strong></td>
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<td>25%</td>
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**Final in-school percentage score**

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<th>Final in-school percentage score</th>
<th>IN-SCHOOL %</th>
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<table>
<thead>
<tr>
<th>In-school Percentage Score</th>
<th>80%</th>
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<td>Combined theory and practical subject competency multiplied by</td>
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<table>
<thead>
<tr>
<th>Standard Level Exam Percentage Score</th>
<th>20%</th>
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<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Final Percentage Score</th>
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### Appendix B
#### Assessment Guidelines

**INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 4 0015MW**

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<th>PRACTICAL WEIGHTING</th>
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<td>A</td>
<td>Work Practices</td>
<td>14%</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>Trade Science</td>
<td>14%</td>
<td>0%</td>
</tr>
<tr>
<td>E</td>
<td>Install Equipment</td>
<td>14%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>Maintain Prime Movers</td>
<td>14%</td>
<td>25%</td>
</tr>
<tr>
<td>I</td>
<td>Service Fluid Power</td>
<td>14%</td>
<td>25%</td>
</tr>
<tr>
<td>J</td>
<td>Service Compressors</td>
<td>14%</td>
<td>25%</td>
</tr>
<tr>
<td>M</td>
<td>Operational Equipment Effectiveness</td>
<td>16%</td>
<td>25%</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

In-school theory / practical subject competency weighting

<table>
<thead>
<tr>
<th>Line</th>
<th>Theory %</th>
<th>Practical %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75%</td>
<td>25%</td>
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</table>

**Final in-school percentage score**

Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal or ITA CofQ exam.

All apprentices who complete Level 4 of the Industrial Mechanic (Millwright) program with a FINAL level percentage score of 70% or greater will write the Interprovincial Red Seal as their final assessment.

ITA will enter the apprentices’ Industrial Mechanic (Millwright) Interprovincial examination mark in ITA Direct Access. A minimum mark of 70% on the examination is required for a pass.
Appendix C

Previous Contributors
Appendix C
Previous Contributors

The Program Standards for Millwright 2008 were updated through a Standards Review project funded by the Industry Training Authority.

The work was coordinated by a joint management / labour committee that included representation from a broad cross section of employers of Millwrights, Millwright labour representatives and a representative from BC’s post-secondary system. These revised standards incorporate changes made to the National Occupational Analysis (Millwright) released in 2007.

The standards were reviewed and adjusted by a group of Subject Matter Experts (SMEs), all Millwrights, as well as two instructors from Colleges that currently teach the Millwright program. The SME group met for two days in August 2008, and for three additional days in December 2008. The SMEs were drawn from a wide cross section of industry and thanks are extended to them for their dedication and participation in keeping Millwright Program Standards technologically current and aligned with the needs of industry.

Millwright Standards Project SMEs (2008)

- Gord Balfour     Millwrights, Machine Erectors and Maintenance Union
- Bob Davis        BC Federation of Labour
- Steve Hall       Coast Industrial
- Mike Hereward    BCIT
- David Hiltz      Port Alberni Pulp & Paper
- Bruce McKague    Highland Valley Copper (Teck)
- Doug Wiebe       Kwantlen Polytechnic University