PROGRAM OUTLINE

Industrial Mechanic
(Millwright)
The latest version of this document is available in PDF format on the ITA website www.itabc.ca

To order printed copies of Program Outlines or learning resources (where available) for BC trades contact:

Crown Publications, Queen’s Printer
Web: www.crownpub.bc.ca
Email: crownpub@gov.bc.ca
Toll Free 1 800 663-6105

Copyright © 2017 Industry Training Authority
This publication may not be modified in any way without permission of the Industry Training Authority
INDUSTRIAL MECHANIC (MILLWRIGHT) PROGRAM OUTLINE

APPROVED BY INDUSTRY
MARCH 2017

BASED ON
RSOS 2016

Developed by
Industry Training Authority
Province of British Columbia
# TABLE OF CONTENTS

## Section 1 INTRODUCTION
- Foreword .............................................................................................................. 4
- Acknowledgements ................................................................................................. 5
- How to Use this Document ..................................................................................... 6

## Section 2 PROGRAM OVERVIEW
- Program Credentialing Model .................................................................................. 9
- Occupational Analysis Chart .................................................................................... 10
- Training Topics and Suggested Time Allocation: Level 1 ......................................... 15
- Training Topics and Suggested Time Allocation: Level 2 ......................................... 16
- Training Topics and Suggested Time Allocation: Level 3 ......................................... 17
- Training Topics and Suggested Time Allocation: Level 4 ......................................... 18

## Section 3 PROGRAM CONTENT
- Level 1 Industrial Mechanic (Millwright) ................................................................. 20
- Level 2 Industrial Mechanic (Millwright) ................................................................. 56
- Level 3 Industrial Mechanic (Millwright) ................................................................. 99
- Level 4 Industrial Mechanic (Millwright) ................................................................. 134

## Section 4 TRAINING PROVIDER STANDARDS
- Facility Requirements ............................................................................................... 165
- Tools and Equipment ............................................................................................... 166
- Reference Materials ................................................................................................ 171
- Instructor Requirements ......................................................................................... 172

## Appendices
- APPENDIX A: Assessment Guidelines .................................................................... 174
  - Level 1 Grading Sheet: Subject Competency and Weightings .............................. 175
  - Level 2 Grading Sheet: Subject Competency and Weightings .............................. 176
  - Level 3 Grading Sheet: Subject Competency and Weightings .............................. 177
  - Level 4 Grading Sheet: Subject Competency and Weightings .............................. 178

- APPENDIX B: Glossary of Terms and Acronyms ..................................................... 179
  - Appendix B: Glossary of Terms and Acronyms .................................................... 180

- APPENDIX C: Previous Contributors .................................................................... 182
  - Appendix C: Previous Contributors ..................................................................... 183
Section 1
INTRODUCTION

Industrial Mechanic (Millwright)
Foreword

The Program Standards for Industrial Mechanic (Millwright) 2017 were updated through a Standards Review project funded by the Industry Training Authority.

These revised standards incorporate changes made to the Industrial Mechanic (Millwright) Red Seal Occupational Analysis (RSOS) released in 2016. The standards were reviewed and adjusted by a group of Subject Matter Experts (SMEs), during a five day workshop in March 2017.

Thanks are extended to SMEs for their dedication and participation in keeping Industrial Mechanic (Millwright) Program Standards technologically current and aligned with the needs of industry.

SAFETY ADVISORY

Be advised that references to the WorkSafe BC 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

Key stakeholders from industry sectors including employers, associations, training providers, and trades workers were integral to the guidance of this program development project.

Industry Subject Matter Experts retained to assist in the development of Occupational Analysis Chart (OAC):

- David Hiltz       Catalyst Paper
- Ed Leonard        Teck Resources Limited
- Keith Belcourt    LRF Contracting Ltd.
- Steve Greenwood   Teck Resources Limited
- Travis Emel        Canfor

Industry Subject Matter Experts retained to assist in the development of the Program Outline:

- Brian McClinton   Kwantlen Polytechnic University
- Bryan Messer      BCIT
- Doug Weibe        Former instructor - retired
- Ed Leonard        Teck Resources Limited
- Gord Balfour      Millwrights, Machine Erectors and Maintenance Local Union 2736
- Nelson Schneider  Canfor
- Rick Czar         College of the Rockies
- Steve Greenwood   Teck Resources Limited

The Industry Training Authority would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Industrial Mechanic (Millwright) occupation.
# 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>Program Credentialing Model</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>OAC</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>Training Topics and Suggested Time Allocation</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>Program Content</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>Section</td>
<td>Training Providers</td>
<td>Employers/Sponsors</td>
<td>Apprentices</td>
<td>Challengers</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Training Provider Standards</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>
<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

Industrial Mechanic (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

Industrial Mechanic (Millwright) Level 4
Technical Training: 210 hours
Work-Based Training: 6,360 hours total
Interprovincial Red Seal Exam

Industrial Mechanic (Millwright) Level 3
Technical Training: 210 hours
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Industrial Mechanic (Millwright) Level 2
Technical Training: 210 hours
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Industrial Mechanic (Millwright) Level 1
Technical Training: 210 hours
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Industrial Mechanic (Millwright) Foundation Program
Technical Training: 720 hours

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

APPRENTICESHIP - DIRECT ENTRY

RESEARCH TEAM

Industrial Mechanic (Millwright) 03/17
Occupational Analysis Chart

INDUSTRIAL MECHANIC (MILLWRIGHT)

Occupation Description: “Industrial Mechanic (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>PERFORM SAFETY RELATED FUNCTIONS</th>
<th>PERFORM ROUTINE TRADE ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>Use codes, regulations and standards</td>
<td>Use mathematics and science</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Use personal protective equipment (PPE) and safety equipment</td>
<td>Plan work</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maintain safe worksite</td>
<td>Lubricate systems and components</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Perform lock-out, tag-out and zero energy procedures</td>
<td>Perform leveling of components and systems</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>USE TOOLS AND EQUIPMENT</td>
<td>Use fastening and retaining devices</td>
</tr>
<tr>
<td>B</td>
<td>C5</td>
</tr>
<tr>
<td>Use hand and portable power tools</td>
<td>Use manufacturer, supplier and reference documentation</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Use shop machines</td>
<td>Use access equipment</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Use access equipment</td>
<td>Use access equipment</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>Use manufacturer, supplier and reference documentation</td>
</tr>
<tr>
<td>C</td>
<td>C6</td>
</tr>
<tr>
<td>Use mathematics and science</td>
<td>Use fastening and retaining devices</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Perform material identification</td>
<td>Use mechanical drawings and specifications</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
## Program Overview

### Use Communication and Mentoring Techniques
- **D**
  - Use communication techniques
  - Use mentoring techniques

### Perform Measuring and Layout of Work Piece
- **E**
  - Prepare work area, tools and equipment
  - Layout and fabricate work piece

### Perform Cutting and Welding Operations
- **F**
  - Cut material with oxy-fuel and plasma arc cutting equipment
  - Weld material using shielded arc welding equipment (SMAW)
  - Weld material with gas metal arc welding equipment (GMAW)
  - Weld material with gas tungsten arc welding equipment (GTAW)

### Perform Rigging, Hoisting/Lifting and Moving
- **G**
  - Select and use sling and rigging attachments
  - Select and use hoisting and lifting equipment
  - Create a rigging plan

### Service Shafts, Bearings and Seals
- **H**
  - Select, install and maintain shafts
  - Select, install and maintain bearings
  - Select, install and maintain seals

### Service Couplings, Clutches and Brakes
- **I**
  - Select, install and maintain couplings
  - Select, install and maintain clutches and brakes
Program Overview

SERVICE CHAIN AND BELT DRIVE SYSTEMS

J1. Select, install and maintain chain drive systems
J2. Select, install and maintain belt drive systems

SERVICE GEAR SYSTEMS

K1. Select and install gear systems
K2. Diagnose, maintain and repair gear systems

PERFORM SHAFT ALIGNMENT PROCEDURES

L1. Perform rough alignment
L2. Perform dial alignment procedures
L3. Perform laser alignment

SERVICE FANS AND BLOWERS

M1. Select, install and maintain fans
M2. Select, install and maintain blowers

SERVICE PUMPS

N1. Identify and select positive displacement pumps
N2. Install, maintain and repair positive displacement pumps
N3. Identify and select non-positive displacement pumps
N4. Install, maintain and repair non-positive displacement pumps

SERVICE COMPRESSORS

O1. Identify and select compressors
O2. Install, maintain and repair compressors
### Program Overview

<table>
<thead>
<tr>
<th>Service Area</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Service Piping, Tanks and Containers</strong></td>
<td>P1: Select, install and maintain process tanks and containers</td>
</tr>
<tr>
<td></td>
<td>P2: Select, install and maintain piping</td>
</tr>
<tr>
<td><strong>Service Hydraulic Systems</strong></td>
<td>Q1: Identify hydraulic components</td>
</tr>
<tr>
<td></td>
<td>Q2: Assemble hydraulic circuits</td>
</tr>
<tr>
<td></td>
<td>Q3: Maintain and repair hydraulic systems</td>
</tr>
<tr>
<td><strong>Service Pneumatic and Vacuum Systems</strong></td>
<td>R1: Identify pneumatic and vacuum components</td>
</tr>
<tr>
<td></td>
<td>R2: Assemble pneumatic and vacuum circuits</td>
</tr>
<tr>
<td></td>
<td>R3: Maintain and repair pneumatic and vacuum systems</td>
</tr>
<tr>
<td><strong>Service Conveying Systems</strong></td>
<td>S1: Identify conveying system components</td>
</tr>
<tr>
<td></td>
<td>S2: Assemble conveying systems</td>
</tr>
<tr>
<td></td>
<td>S3: Maintain and repair conveying systems</td>
</tr>
<tr>
<td><strong>Service Prime Movers</strong></td>
<td>T1: Service electric motors</td>
</tr>
<tr>
<td></td>
<td>T2: Service internal combustion engines</td>
</tr>
<tr>
<td></td>
<td>T3: Service turbines</td>
</tr>
<tr>
<td><strong>Perform Preventative and Predictive Maintenance</strong></td>
<td>U1: Perform preventative and predictive maintenance activities</td>
</tr>
<tr>
<td></td>
<td>U2: Perform vibration analysis procedures</td>
</tr>
<tr>
<td></td>
<td>U3: Perform balancing procedures</td>
</tr>
<tr>
<td></td>
<td>U4: Perform non-destructive evaluation (NDE) procedures</td>
</tr>
</tbody>
</table>
### Program Overview

**Perform Commissioning and Decommissioning of Equipment**

<table>
<thead>
<tr>
<th>ID</th>
<th>Task</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Commission systems and components</td>
<td>4</td>
</tr>
<tr>
<td>V2</td>
<td>Decommission systems and components</td>
<td>4</td>
</tr>
</tbody>
</table>

**Service Robotics and Automated Equipment**

<table>
<thead>
<tr>
<th>ID</th>
<th>Task</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>Service robotics and automated equipment</td>
<td>4</td>
</tr>
</tbody>
</table>
## Training Topics and Suggested Time Allocation: Level 1

**INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 1**

<table>
<thead>
<tr>
<th>Line A</th>
<th>PERFORM SAFETY RELATED FUNCTIONS</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Use codes, regulations and standards</td>
<td>17%</td>
<td>90%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>A2</td>
<td>Use personal protective equipment (PPE) and safety equipment</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Maintain safe worksite</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Perform lock-out, tag-out and zero energy procedures</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line B</th>
<th>USE TOOLS AND EQUIPMENT</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Use hand and portable power tools</td>
<td>22%</td>
<td>70%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>B2</td>
<td>Use shop machines</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>Use access equipment</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line C</th>
<th>PERFORM ROUTINE TRADE ACTIVITIES</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Use mathematics and science</td>
<td>30%</td>
<td>90%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>C3</td>
<td>Lubricate systems and components</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Perform leveling of components and systems</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>Use fastening and retaining devices</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>Use manufacturer, supplier and reference documentation</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>Use mechanical drawings and specifications</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line D</th>
<th>USE COMMUNICATION AND MENTORING TECHNIQUES</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Use communication techniques</td>
<td>2%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line E</th>
<th>PERFORM MEASURING AND LAYOUT OF WORK PIECE</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Prepare work area, tools and equipment</td>
<td>6%</td>
<td>70%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>E2</td>
<td>Layout and fabricate work piece</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line F</th>
<th>PERFORM CUTTING AND WELDING OPERATIONS</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Cut material with oxy-fuel and plasma arc cutting equipment</td>
<td>13%</td>
<td>25%</td>
<td>75%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line G</th>
<th>PERFORM RIGGING, HOISTING/LIFTING AND MOVING</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>Select and use sling and rigging attachments</td>
<td>10%</td>
<td>75%</td>
<td>25%</td>
<td>100%</td>
</tr>
<tr>
<td>G2</td>
<td>Select and use hoisting and lifting equipment</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>G3</td>
<td>Create a rigging plan</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

**Total Percentage for Millwright Level 1**

100%
Training Topics and Suggested Time Allocation: Level 2

INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 2

<table>
<thead>
<tr>
<th>Line</th>
<th>Topic</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>25%</td>
<td>85%</td>
<td>15%</td>
<td>100%</td>
</tr>
<tr>
<td>C1</td>
<td>Use mathematics and science</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Lubricate systems and components</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Perform leveling of components and systems</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>Perform material identification</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>Perform heat treatment of metal</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>Use mechanical drawings and specifications</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>PERFORM CUTTING AND WELDING OPERATIONS</td>
<td>14%</td>
<td>25%</td>
<td>75%</td>
<td>100%</td>
</tr>
<tr>
<td>F2</td>
<td>Weld material using shielded arc welding equipment (SMAW)</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>Weld material with gas metal arc welding equipment (GMAW)</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>F4</td>
<td>Weld material with gas tungsten arc welding equipment (GTAW)</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>SERVICE SHAFTS, BEARINGS AND SEALS</td>
<td>19%</td>
<td>75%</td>
<td>25%</td>
<td>100%</td>
</tr>
<tr>
<td>H1</td>
<td>Select, install and maintain shafts</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>Select, install and maintain bearings</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>Select, install and maintain seals</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>SERVICE COUPLINGS, CLUTCHES AND BRAKES</td>
<td>10%</td>
<td>90%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>I1</td>
<td>Select, install and maintain couplings</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>I2</td>
<td>Select, install and maintain clutches and brakes</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>SERVICE CHAIN AND BELT DRIVE SYSTEMS</td>
<td>12%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>J1</td>
<td>Select, install and maintain chain drive systems</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>J2</td>
<td>Select, install and maintain belt drive systems</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>SERVICE GEAR SYSTEMS</td>
<td>10%</td>
<td>70%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>K1</td>
<td>Select and install gear systems</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K2</td>
<td>Diagnose, maintain and repair gear systems</td>
<td></td>
<td>✔️ ✔️</td>
<td>✔️ ✔️</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>PERFORM SHAFT ALIGNMENT PROCEDURES</td>
<td>10%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>L1</td>
<td>Perform rough alignment</td>
<td></td>
<td>✔️ ✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>Perform dial alignment procedures</td>
<td></td>
<td>✔️ ✔️</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Percentage for Millwright Level 2: 100%
# Program Overview

## Training Topics and Suggested Time Allocation: Level 3

### INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 3

<table>
<thead>
<tr>
<th>Line</th>
<th>Topic</th>
<th>% of Time Allocated to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% of Time</td>
</tr>
<tr>
<td>Line C</td>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>9%</td>
</tr>
<tr>
<td>C1</td>
<td>Use mathematics and science</td>
<td>✔</td>
</tr>
<tr>
<td>C4</td>
<td>Perform leveling of components and systems</td>
<td>✔</td>
</tr>
<tr>
<td>C9</td>
<td>Use mechanical drawings and specifications</td>
<td>✔</td>
</tr>
<tr>
<td>Line L</td>
<td>PERFORM SHAFT ALIGNMENT PROCEDURES</td>
<td>4%</td>
</tr>
<tr>
<td>L2</td>
<td>Perform dial alignment</td>
<td>✔</td>
</tr>
<tr>
<td>L3</td>
<td>Perform laser alignment</td>
<td>✔</td>
</tr>
<tr>
<td>Line M</td>
<td>SERVICE FANS AND BLOWERS</td>
<td>5%</td>
</tr>
<tr>
<td>M1</td>
<td>Select, install and maintain fans</td>
<td>✔</td>
</tr>
<tr>
<td>M2</td>
<td>Select, install and maintain blowers</td>
<td></td>
</tr>
<tr>
<td>Line N</td>
<td>SERVICE PUMPS</td>
<td>19%</td>
</tr>
<tr>
<td>N1</td>
<td>Identify and select positive displacement pumps</td>
<td>✔</td>
</tr>
<tr>
<td>N2</td>
<td>Install, maintain and repair positive displacement pumps</td>
<td>✔</td>
</tr>
<tr>
<td>N3</td>
<td>Identify and select non-positive displacement pumps</td>
<td>✔</td>
</tr>
<tr>
<td>N4</td>
<td>Install, maintain and repair non-positive displacement pumps</td>
<td>✔</td>
</tr>
<tr>
<td>Line O</td>
<td>SERVICE COMPRESSORS</td>
<td>15%</td>
</tr>
<tr>
<td>O1</td>
<td>Identify and select compressors</td>
<td></td>
</tr>
<tr>
<td>O2</td>
<td>Install, maintain and repair compressors</td>
<td></td>
</tr>
<tr>
<td>Line P</td>
<td>SERVICE PIPING, TANKS AND CONTAINERS</td>
<td>10%</td>
</tr>
<tr>
<td>P1</td>
<td>Select, install and maintain process tanks and containers</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>Select, install and maintain piping</td>
<td>✔</td>
</tr>
<tr>
<td>Line Q</td>
<td>SERVICE HYDRAULIC SYSTEMS</td>
<td>29%</td>
</tr>
<tr>
<td>Q1</td>
<td>Identify hydraulic components</td>
<td>✔</td>
</tr>
<tr>
<td>Q2</td>
<td>Assemble hydraulic circuits</td>
<td>✔</td>
</tr>
<tr>
<td>Q3</td>
<td>Maintain and repair hydraulic systems</td>
<td></td>
</tr>
<tr>
<td>Line R</td>
<td>SERVICE PNEUMATIC AND VACUUM SYSTEMS</td>
<td>9%</td>
</tr>
<tr>
<td>R1</td>
<td>Identify pneumatic and vacuum components</td>
<td>✔</td>
</tr>
<tr>
<td>R2</td>
<td>Assemble pneumatic and vacuum circuits</td>
<td>✔</td>
</tr>
<tr>
<td>R3</td>
<td>Maintain and repair pneumatic and vacuum systems</td>
<td>✔</td>
</tr>
</tbody>
</table>

**Total Percentage for Millwright Level 3**

100%
## Training Topics and Suggested Time Allocation: Level 4

### INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 4

<table>
<thead>
<tr>
<th>Line</th>
<th>Topic</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Line C</strong></td>
<td><strong>PERFORM ROUTINE TRADE ACTIVITIES</strong></td>
<td>18%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>C1</td>
<td>Use mathematics and science</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>Plan work</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Perform leveling of components and systems</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>Use mechanical drawings and specifications</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line D</th>
<th><strong>USE COMMUNICATION AND MENTORING TECHNIQUES</strong></th>
<th>3%</th>
<th>100%</th>
<th>0%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Use communication techniques</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>Use mentoring techniques</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line S</th>
<th><strong>SERVICE CONVEYING SYSTEMS</strong></th>
<th>17%</th>
<th>80%</th>
<th>20%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Identify conveying systems</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>Assemble conveying systems</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>Maintain and repair conveying systems</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line T</th>
<th><strong>SERVICE PRIME MOVERS</strong></th>
<th>30%</th>
<th>80%</th>
<th>20%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Service electric motors</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>Service internal combustion engines</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>Service turbines</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line U</th>
<th><strong>PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE</strong></th>
<th>13%</th>
<th>100%</th>
<th>0%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>Perform preventative and predictive maintenance activities</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U2</td>
<td>Perform vibration analysis procedures</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U3</td>
<td>Perform balancing procedures</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U4</td>
<td>Perform non-destructive evaluation (NDE) procedures</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line V</th>
<th><strong>PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT</strong></th>
<th>7%</th>
<th>90%</th>
<th>10%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Commission systems and components</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>Decommission systems and components</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line W</th>
<th><strong>SERVICE ROBOTICS AND AUTOMATED EQUIPMENT</strong></th>
<th>12%</th>
<th>100%</th>
<th>0%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>Service robotics and automated equipment</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

PROGRAM CONTENT

Industrial Mechanic (Millwright)
Level 1

Industrial Mechanic (Millwright)
Program Content
Level 1

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A1 Use codes, regulations and standards

Objectives
To be competent in this area, the individual must be able to:
• Determine and apply jurisdictional regulations.

LEARNING TASKS

1. Define terms used in Federal-Provincial Occupational Health and Safety Regulations
   • Workers Compensation Act
   • Industrial Health and Safety Regulations
   • Federal Regulations
   • British Columbia Mines Act
   • Workplace Hazardous Materials Information System (WHMIS 2015)

2. Describe the Occupational Health and Safety Regulations
   • Personal protective equipment (PPE)
   • Housekeeping
   • Confined Space
   • Material Storage
   • Ladders/Scaffolding
   • Fall Arrest
   • WHMIS 2015
   • Lockout/tagout procedures
   • Ventilation requirements

3. Describe HAZMAT regulations for the transportation of hazardous materials
   • Signage
   • Reporting incidents
   • Safe handling and cleanup procedures
   • Transporting
**Objectives**

To be competent in this area, the individual must be able to:
- Identify the personal protective equipment (PPE) required for various situations.
- Use personal protective equipment (PPE) and explain proper maintenance and storage techniques.

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Identify and select personal safety equipment</strong></td>
</tr>
<tr>
<td>• Jurisdictional regulations</td>
</tr>
<tr>
<td>• Respirators</td>
</tr>
<tr>
<td>• Eye protection / face shield</td>
</tr>
<tr>
<td>• Eye-wash stations</td>
</tr>
<tr>
<td>• Hearing protection</td>
</tr>
<tr>
<td>• Hand protection</td>
</tr>
<tr>
<td>• Head protection</td>
</tr>
<tr>
<td>• Foot protection</td>
</tr>
<tr>
<td>• Clothing (safety vest, coveralls)</td>
</tr>
<tr>
<td>• Fall arrest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Use personal safety equipment</strong></td>
</tr>
<tr>
<td>• Respirators</td>
</tr>
<tr>
<td>• Eye protection / face shield</td>
</tr>
<tr>
<td>• Eye-wash stations</td>
</tr>
<tr>
<td>• Hearing protection</td>
</tr>
<tr>
<td>• Hand protection</td>
</tr>
<tr>
<td>• Head protection</td>
</tr>
<tr>
<td>• Foot protection</td>
</tr>
<tr>
<td>• Clothing (safety vest, coveralls)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Explain the proper maintenance and storage of personal safety equipment</strong></td>
</tr>
<tr>
<td>• Respirators</td>
</tr>
<tr>
<td>• Eye protection / face shield</td>
</tr>
<tr>
<td>• Eye-wash stations</td>
</tr>
<tr>
<td>• Hearing protection</td>
</tr>
<tr>
<td>• Hand protection</td>
</tr>
<tr>
<td>• Head protection</td>
</tr>
<tr>
<td>• Clothing (safety vest, coveralls)</td>
</tr>
<tr>
<td>• Fall arrest</td>
</tr>
</tbody>
</table>
Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A3 Maintain safe worksite

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.
• 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
     o Welding hazards
     o Chemical hazards
     o Electrical hazards
     o Improper disposal of combustible / flammable materials

2. Describe the required jurisdictional regulations
   - Hazardous Product Act (TDG)
   - Controlled Products Regulations (WHMIS 2015)
   - Ingredient Disclosure List
   - Jurisdictional regulations
     o Hazardous Materials Information Review Act and Regulations

   - Worker protection
     o Hazardous materials
     o Relevant information
   - Economic impact
   - Minimize work disruptions
## LEARNING TASKS

| 4. | Describe the key elements of WHMIS 2015 |
| 5. | Describe the responsibilities of suppliers under WHMIS 2015 |
| 6. | Describe the responsibilities of employers under WHMIS 2015 |
| 7. | Describe information to be disclosed on a SDS |
| 8. | Identify symbols found on WHMIS 2015 labels and their meaning |
| 9. | Explain how WHMIS 2015 applies to hazardous materials used in the shop |
| 10. | Describe proper use of guards and guarding for various situations |

## CONTENT

- Recognition of rights
  - Workers
  - Employers
  - Suppliers
  - Regulators
- Safety data sheets (SDS)
- Hazardous material labelling
- Worker education programs
- Provide
  - SDSs
  - Labels
- Provide
  - SDSs
  - Labels
  - Work education programs in the workplace
- Hazardous ingredients
- Preparation information
- Product information
- Physical data
- Fire or explosion
- Reactivity data
- Toxicological properties
- Preventive measures
- First-aid measures
- 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
- Use, storage and disposal
  - Solvents
  - Caustic cleaners
  - Cleaning solutions
- CSA Standards
- Styles
  - Interlock
  - Standard
  - Enclosed
11. Describe the use of work platforms
   • Elevated platforms
   • Guard rails
   • Stairs
   • Toe-boards
   • Jurisdictional regulations

12. Describe the use of work permits
   • Job site policy
   • Equipment release for maintenance
   • Overlapping safety considerations

13. Identify various types of fires
   • Type A
   • Type B
   • Type C
   • Type D

14. Explain principles of fire fighting
   • Fire triangle
   • Flammable liquids
   • Loose material
   • Gas
   • Company specific firefighting procedures

15. Describe the proper use of fire extinguishers
   • Handling and usage (PASS)
   • Storage
   • Inspection
     o Signed
     o Dated
     o Sealed
   • Identification
     o Colour
     o Shape
     o Lettering

16. Describe the considerations and steps to be taken prior to fighting a fire
   • Warning others and notifying fire department
   • Evacuation of others
   • Fire containment
   • Personal method of egress
   • Training

17. Identify lifting risks and considerations
   • Lift techniques
   • Limitations
   • Personal safety equipment

18. Demonstrate safe lifting techniques
   • Legs
   • Hands
   • Arms
   • Back
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 19. Identify the risks of repetitive motion | • Ergonomics  
• Repetitive motion  
  o Hand  
  o Arm  
  o Back |
Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A4 Perform lock-out, tag-out and zero energy procedures

Objectives
To be competent in this area, the individual must be able to:
• Identify energy sources and lock-out requirements
• Identify lock-out and tag-out procedures.
• Use lock-out and tag-out procedures

LEARNING TASKS
1. Identify energy sources and lock-out requirements
   • Zero energy
     o Depressurize
     o Jurisdictional regulations
   • Energy sources
2. Identify lock-out and tag-out procedures
   • Lock
   • Tags
   • Cable
   • Lock box
   • Blocking
   • Blanking
   • Gravity
   • Stored energy
3. Identify zero energy state
   • Zero energy state
     o Disconnect
     o Depressurize
     o Isolate
   • Lock-out
   • Test
4. Use lock-out and tag-out procedures
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B1 Use hand and portable power tools

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

- Use and maintain hand and portable power tools.

LEARNING TASKS

1. Identify hand and portable power tools

2. Use hand and portable power tools

3. Inspect, maintain and store hand and portable power tools

CONTENT

- Hand tools
  - Terminology
  - Striking tools
  - Wrenches/sockets
  - Screw drivers
  - Cutting tools
  - Clamping devices
  - Pullers

- Power tools
  - Drills
  - Impact guns
  - Cutting
  - Grinding
  - Powder actuated
  - Key seat cutter

- Hand tools
  - Terminology
  - Striking tools
  - Wrenches/sockets
  - Screw drivers
  - Cutting tools
  - Clamping devices
  - Pullers

- Power tools
  - Drills
  - Impact guns
  - Cutting
  - Grinding
  - Powder actuated
  - Key seat cutter

- Wear
- Damage
- Repair
- Remove from service
- Clean
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B2 Use shop machines

Objectives
To be competent in this area, the individual must be able to:
• Set up, use and maintain shop machines.

LEARNING TASKS
1. Describe shop machines and their applications
   • Lathes
   • Milling machines
   • Grinders
   • Drill presses
   • Saws
   • Cut-off tools
   • Threading machines
   • Presses

2. Explain safe use of shop machines
   • Jurisdictional regulations
     o Site policy
   • Machine shop safety
   • Personal safety
   • Intrinsically safe tools

3. Set-up and use shop machines
   • Types
   • Feed rates
   • Speeds
   • Clamping

4. Maintain shop machines
   • Inspection
   • Troubleshooting
   • Clean and lubricate
Program Content
Level 1

Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B3 Use access equipment

Objectives
To be competent in this area, the individual must be able to:
• Use access equipment.

LEARNING TASKS
1. Identify types of access equipment and their applications
   • Powered mobile equipment
     o Fork lift/basket
     o Scissor
     o Boom lift
   • Ladders
   • Scaffolds

2. Select and use access equipment
   • Jurisdictional regulations
   • Fall protection
   • Maintenance
     o Unsafe equipment
     o Pre-use inspection
   • Care and storage
Program Content
Level 1

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C1 Use mathematics and 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.
• Use mathematical calculations to perform duties.

LEARNING TASKS

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
     o Addition
     o Subtraction
     o Multiplication
     o Division

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

4. Solve problems using decimal fractions
   • Terminology
     o Decimal system
     o Place value
     o Rounding off
     o Repeating decimal
     o Significant digit
   • Perform mathematical calculations
     o Addition
     o Subtraction
     o Multiplication
     o Division
LEARNING TASKS

5. Solve problems using ratio and proportion
   • Terminology
     o Ratio
     o Terms
     o Proportion
     o Cross multiplication
     o Inverse ratio
     o Inverse proportion
   • Ratio calculations
   • Proportion calculations
     o Proper proportions
     o Inverse proportions

6. Solve problems with percentages
   • Terminology
     o Common fraction
     o Decimal fraction
   • Percentage calculations

7. Solve problems dealing with perimeters and circumference
   • Concept of perimeters
   • Geometric shapes
     o Squares
     o Triangles
     o Rectangles
     o Arcs
     o Circles/ellipse

8. Solve problems dealing with areas and volumes
   • Concept of area
   • Geometric shapes
     o Squares
     o Triangles
     o Rectangles
     o Arcs
     o Circles/ellipse
   • Concept of volume
   • Terminology
   • Transpose formulas
   • Transpose equations
   • Algebra calculations

9. Solve problems using algebra
   • Terminology

10. Solve problems using metric and imperial units
    • Terminology
      o Length, area and volume
      o Weight
      o Temperature
    • Metric and imperial conversion
    • Metric and imperial calculations
**Program Content**

**Level 1**

**Line (GAC):** C  PERFORM ROUTINE TRADE ACTIVITIES

**Competency:** C3  Lubricate systems and components

### Objectives

To be competent in this area, the individual must be able to:
- Describe lubrication types and systems.
- Describe the safe use, storage and handling of lubricants.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>LEARNING TASKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe types of friction</td>
<td></td>
</tr>
<tr>
<td>2. Describe oil lubrication</td>
<td></td>
</tr>
<tr>
<td>3. Describe types of lubricants</td>
<td></td>
</tr>
<tr>
<td>4. Describe various lubrication systems</td>
<td></td>
</tr>
<tr>
<td>5. Describe handling procedures</td>
<td></td>
</tr>
</tbody>
</table>

### CONTENT

- **Types of friction**
  - Rolling
  - Sliding
  - Fluid
  - Starting
- **Causes of friction**
- **Effects of friction**
- **Oil wedge**
- **Boundary**
- **Full film**
- **Types**
  - Grease
  - Oil
  - Synthetic oils
- **Automatic**
- **Pressure**
- **Gravity**
- **Reservoir**
- **Splash**
- **Flinger**
- **Manual**
- **Capillary**
- **Injector**
- **Safe handling**
- **WHMIS 2015**
- **Storage**
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C4 Perform leveling of components and systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the use of layout tools.
• Describe appropriate layout procedures for the installation of machinery.
• Explain the safe use and handling of grouts.
• Describe equipment foundations and associated materials.

LEARNING TASKS
1. Identify layout tools
   • Tools
     o Measuring tape
     o Gauge
     o Level
       − Spirit
       − Optical
       − Laser
     o Transit
     o Piano wire
     o Plumb bob
     o Straight edge
     o Square

2. Describe equipment layout procedures
   • Maintenance procedures
   • Layout procedures
     o Machine location and alignment to associated equipment
     o Machine bases
     o Installation of machine components
       − Base lines and center 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
     o Types of anchors
       − Expansion shield
       − Solid slug-ins
       − Leaded
       − Toggle
       − Boxed bolts
       − Hooks and tees
     o Types of anchor bolts
       − Fixed
       − Pipe or tube
       − Boxed
     o Anchor installation
LEARNING TASKS

4. Describe equipment foundations

5. Identify levelling and alignment tools

6. Describe levelling and alignment procedures

CONTENT

− 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

4. Describe equipment foundations

Foundation materials

− Concrete
− Reinforced concrete
− Steel / wood

Cast

− Sole plates

Fabricated

− Skid mounted

Grouts

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

5. Identify levelling and alignment tools

Alignment tools

− Types
− Uses
− Care
− Maintenance

6. Describe levelling and alignment procedures

Machine reference points

− Centre lines
− Base lines
− Elevation marks

Elevation and position

− Engineers reference point
− Bench mark
− Piano wire
− Laser level
− Optical level
− Straight edge
− Machinist level
− Jig transit

Procedures

− Levelling equipment
  − Instruments
LEARNING TASKS

CONTENT
- Shims
- Jacking screws
- Self levelling
- Fox wedges
  - Machine components
    - Rolls
    - Hubs
    - Bearings
    - Sprockets
    - Sheaves
    - Reduction units
    - Machine bases and sub-bases
    - Rails
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C5  Use fastening and retaining devices

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
   - Standards organizations
     - 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 marking
     - Metric
     - Imperial
   - Thread form
     - ANC (American National)
     - UN (Unified National)
     - Metric
     - Whitworth
     - Buttress
     - Square
     - Acme
   - Fastener dimension
     - 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

CONTENT
- Wrenches
- Slug wrenches
- Hydraulic wrenches
- Impact wrenches
- Snap-ring pliers
- Riveting devices

4. Describe methods and set torque values

CONTENT
- Torque wrenches
- Hydraulic wrenches
- Stretch method
- Refer to service manuals

5. Describe methods used to calculate strengths of fasteners

CONTENT
- Tensile and shear strength of
  - Bolts
  - Screws
  - Rivets

6. Apply methods of cutting threads and thread recovery

CONTENT
- Tools for cutting threads
  - Taps
  - Dies
  - Thread gauges
  - Threading machines
  - Lathes
- Repair methods for damaged threads
  - Thread chasers
  - Thread files
  - Helicoil
  - Other method
- Drying time
- Material compatibility
- Resistance
  - Water
  - Oil
  - Other substances
- Bonding strength
- Resistance to impact and tension
- Applications
- Specifications

7. Select and use epoxies and resins
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C6  Use manufacturer, supplier and reference documentation

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.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use service manuals to locate information</td>
<td>• Parts</td>
</tr>
<tr>
<td></td>
<td>• Assembly/disassembly instructions</td>
</tr>
<tr>
<td></td>
<td>• Equipment specifications</td>
</tr>
<tr>
<td></td>
<td>• Lubrication specifications</td>
</tr>
<tr>
<td>2. Use industry reference, such as the Machinery's Handbook and IPT rotating equipment handbook to locate information</td>
<td>• Tolerances and fits of components</td>
</tr>
<tr>
<td></td>
<td>• Parts</td>
</tr>
<tr>
<td></td>
<td>• Cutting speeds</td>
</tr>
<tr>
<td></td>
<td>• Material coefficients</td>
</tr>
<tr>
<td></td>
<td>• Material characteristics</td>
</tr>
<tr>
<td>3. Use catalogues to locate information</td>
<td>• Inter-changeability of parts</td>
</tr>
<tr>
<td></td>
<td>• Parts specifications</td>
</tr>
<tr>
<td></td>
<td>• Equipment performance specifications</td>
</tr>
<tr>
<td>4. Use electronic media to locate information</td>
<td>• Parts and parts specifications</td>
</tr>
<tr>
<td></td>
<td>• Inter-changeability of parts</td>
</tr>
<tr>
<td></td>
<td>• Assembly/disassembly instructions</td>
</tr>
<tr>
<td></td>
<td>• Equipment specifications</td>
</tr>
<tr>
<td></td>
<td>• Equipment performance specifications</td>
</tr>
<tr>
<td></td>
<td>• Lubrication specifications</td>
</tr>
<tr>
<td></td>
<td>• Tolerances and fits of components</td>
</tr>
<tr>
<td></td>
<td>• Cutting speeds</td>
</tr>
<tr>
<td></td>
<td>• Material coefficients</td>
</tr>
<tr>
<td></td>
<td>• Material characteristics</td>
</tr>
<tr>
<td></td>
<td>• Running speeds</td>
</tr>
<tr>
<td>5. Use standard codes</td>
<td>• CSA</td>
</tr>
<tr>
<td></td>
<td>• ASTM</td>
</tr>
<tr>
<td></td>
<td>• ANSI</td>
</tr>
<tr>
<td></td>
<td>• API</td>
</tr>
</tbody>
</table>
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C9 Use mechanical drawings and specifications

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.

LEARNING TASKS
1. Identify types of drawings
   • Orthographic
   • Pictorial
   • Working
   • Assembling
   • Installation
   • Sketching
   • CADD

2. Identify elements of a drawing
   • Types of lines
   • Dimensions (metric and imperial)
   • Views
   • Notes and details
   • Labelling
   • Symbols
   • Title blocks
   • Material lists
   • Miscellaneous information
   • Conventions

3. Interpret drawing information
   • Material requirements
   • Fabrication requirements
   • Machining requirements
   • Tolerances and fitting requirements

4. Interpret industrial drawings
   • Mechanical
   • Installation
   • Piping
   • Structural
   • Electrical

5. Produce a sketch
   • Common drawing elements
Achievement Criteria

Performance  The learner will be able to produce a sketch using common drawing elements.

Conditions  The learner will be given:

- Classroom setting
- Object to draw
- Paper
- Pencil & eraser
- Compass & straight edge
- Measuring tools

Criteria  The learner will be evaluated on:

- Components of a drawing
- Sketch to scale
- Title block
- Multi-view
- Accuracy of drawing
Line (GAC): D USE COMMUNICATION AND MENTORING TECHNIQUES
Competency: D1 Use communication techniques

Objectives
To be competent in this area, the individual must be able to:
- Use trade terminology.
- Identify and use record keeping systems.

LEARNING TASKS
1. Demonstrate communication practices
   - Terminology
   - Types
     - Hand signals

2. Use correct trade terminology
   - Taking instructions
   - Giving instructions
   - Parts
   - Concepts

3. Participate in information meetings
   - Tool box
   - Safety
   - Planning

4. Maintain records specific to workplace requirements
   - Service reports
   - Time cards
   - Warranty reports
   - Maintenance reports
   - Purchase orders
   - Parts orders
   - Apprentice journals
   - Paper-based/electronic
   - Functions of maintenance software
     - Scheduling
     - Repair
     - Costing
Program Content
Level 1

Line (GAC): E PERFORM MEASURING AND LAYOUT OF WORK PIECE
Competency: E1 Prepare work area, tools and equipment

Objectives
To be competent in this area, the individual must be able to:
- Identify precision measuring tools and equipment.
- Identify layout tools and instruments.
- Use measuring tools.

LEARNING TASKS
1. Identify and use precision 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. Describe maintenance and storage procedures for measuring tools
   - Maintenance
   - Storage
LEARNING TASKS

3. 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

4. Describe maintenance and storage procedures for layout tools

CONTENT

• Maintenance
• Storage

Achievement Criteria

Performance The learner will be able to determine measurements using precision measurement tools

Conditions The learner will be given:

• Parts for measurement
• Precision measuring tools
• Workbench
• PPE

Criteria The learner will be evaluated on:

• Safety
• Tool use
• Accuracy of measurements
Line (GAC): E PERFORM MEASURING AND LAYOUT OF WORK PIECE
Competency: E2 Layout and fabricate work piece

Objectives
To be competent in this area, the individual must be able to:
• Select and use measuring and layout tools.
• Layout and fabricate work piece.

LEARNING TASKS

1. Select and use measuring tools
   • Accuracy
   • Adjustments and settings
   • Components
     o Diameter
     o Concentricity
     o Parallelism
     o Depth
     o Size
     o Location

2. Select and use layout tools
   • Accuracy
   • Layout tools for geometric shapes
     o Perpendicular lines
     o Bisect lines
     o Divide lines into equal parts
     o Angles
     o Bisect angles
     o Transfer angles
     o Circles
     o Circles within circles
     o Locate centre of circles
     o Hexagons
     o Octagons
     o Triangles

3. Layout work piece
   • Sketch
   • Blueprint
   • Layout tools
   • Measuring tools
   • Interpret and transfer

4. Fabricate work piece
   • Instructions
   • Shop tools
   • Hand tools
   • Material
Achievement Criteria #1

Performance  The learner will be able to fabricate a drill gauge.

Conditions  The learner will be given:
- Drawing
- Materials
- Tools
- Workbench
- PPE

Criteria  The learner will be evaluated on:
- Safety
- Tool use
- Accuracy of fabrication

Achievement Criteria #2

Performance  The learner will be able to fabricate a drill and tap project.

Conditions  The learner will be given:
- Drawing
- Materials
- Tools
- Workbench
- PPE

Criteria  The learner will be evaluated on:
- Safety
- Tool use
- Accuracy of fabrication
### Program Content
#### Level 1

**Line (GAC):** F

**PERFORM CUTTING AND WELDING OPERATIONS**

**Competency:** F1  Cut material with oxy-fuel and plasma arc cutting equipment

### Objectives
To be competent in this area, the individual must be able to:
- Use oxy-acetylene equipment.
- Use and maintain plasma arc cutting equipment.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>Learning Tasks</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe safe work practices welding and cutting</td>
<td>• Fire hazards</td>
</tr>
<tr>
<td></td>
<td>• Safety regulations</td>
</tr>
<tr>
<td></td>
<td>• Safety equipment</td>
</tr>
<tr>
<td></td>
<td>• Fire watch</td>
</tr>
<tr>
<td></td>
<td>• Fire extinguishers</td>
</tr>
<tr>
<td></td>
<td>• Spotter requirements</td>
</tr>
<tr>
<td></td>
<td>• Proper ventilation</td>
</tr>
<tr>
<td></td>
<td>• Confined space</td>
</tr>
<tr>
<td></td>
<td>• Unsafe equipment identification</td>
</tr>
<tr>
<td>2. Describe oxy-acetylene equipment</td>
<td>• Safety precautions</td>
</tr>
<tr>
<td></td>
<td>• Gas types and pressures</td>
</tr>
<tr>
<td></td>
<td>• Handling and storage of gas cylinders</td>
</tr>
<tr>
<td></td>
<td>• Types of equipment</td>
</tr>
<tr>
<td></td>
<td>• Regulators</td>
</tr>
<tr>
<td></td>
<td>• Torches</td>
</tr>
<tr>
<td></td>
<td>• Hoses</td>
</tr>
<tr>
<td></td>
<td>• Cylinders</td>
</tr>
<tr>
<td></td>
<td>• Safety devices</td>
</tr>
<tr>
<td>3. Describe methods and safe work practices for heating</td>
<td>• Pre/post heating</td>
</tr>
<tr>
<td></td>
<td>• Gas types and pressure</td>
</tr>
<tr>
<td></td>
<td>• Propylene</td>
</tr>
<tr>
<td></td>
<td>• Propane</td>
</tr>
<tr>
<td></td>
<td>• Acetylene</td>
</tr>
<tr>
<td></td>
<td>• Oxygen</td>
</tr>
<tr>
<td></td>
<td>• Natural gas</td>
</tr>
<tr>
<td>4. Use oxy-acetylene equipment</td>
<td>• Setup procedures</td>
</tr>
<tr>
<td></td>
<td>• Regulators</td>
</tr>
<tr>
<td></td>
<td>• Torches</td>
</tr>
<tr>
<td></td>
<td>• Hoses</td>
</tr>
<tr>
<td></td>
<td>• Cylinders</td>
</tr>
<tr>
<td></td>
<td>• Safety devices</td>
</tr>
<tr>
<td></td>
<td>• Cutting</td>
</tr>
<tr>
<td></td>
<td>• Material identification</td>
</tr>
<tr>
<td></td>
<td>• Plate</td>
</tr>
<tr>
<td></td>
<td>• Sheet</td>
</tr>
<tr>
<td></td>
<td>• Round stock</td>
</tr>
<tr>
<td></td>
<td>• Rebar</td>
</tr>
</tbody>
</table>
LEARNING TASKS

CONTENT

- Miscellaneous shapes
- Nuts off bolts

- Cutting applications
  - Holes
  - Bevels
  - Angles
  - Freehand and guided cuts

- Welding and brazing
  - Fusion welding
  - Brazing
    - Matching material and rod
    - Torch speed
  - Fluxes

- Weld inspection
  - Undercuts
  - Cracks
  - Porosity

- Weld preparation
  - Clean the material to be welded
  - Plate/joint preparation
  - Preheating material
  - Post heating material

- Maintenance procedures
  - Regulators
  - Torches
  - Hoses
  - Cylinders
  - Safety devices

- Shutdown procedures

- Plasma material cutting

- Heating
  - Rosebuds
  - Acetylene
  - Propylene

5. Describe plasma arc cutting equipment

- Safety precautions
- Gas types and pressures
- Grounding requirements

6. Use plasma arc cutting equipment

- Setup
- Application
- Cutting procedures
- Unsafe equipment identification
- Maintenance procedures
  - Regulators
  - Torch head and components
  - Hoses
  - Safety devices
Achievement Criteria

Performance The learner will be able to cut material provided.

Conditions The learner will be given:
- PPE & fire safety equipment
- Oxy-fuel equipment
- Work area – properly ventilated
- Material
- Cutting requirements

Criteria The learner will be evaluated on:
- Safety
- Safe set up and use of oxy-fuel equipment
- Accuracy and conditions of performed cuts
Line (GAC): G  PERFORM RIGGING, HOISTING/LIFTING AND MOVING
Competency: G1  Select and use sling and rigging attachments

Objectives
To be competent in this area, the individual must be able to:
• Select and use sling and rigging attachments.

LEARNING TASKS
1. Describe jurisdictional regulations
   • Responsibilities of
     o WorkSafeBC
     o Employer
     o Employee
   • Inspection
     o Annual
     o Pre-use
   • Company specific requirement’s (risk assessment)
   • Manufacturers’ specifications

2. Select, inspect and use fibre rope
   • Types and usage
     o Natural
     o Synthetic
   • Construction
   • Maintenance and storage
   • Design factors (working load limit)
   • Rejection criteria
   • Knots
     o Overhand
     o Figure 8
     o Square (reef)
     o Bowline
       − Normal
     o Single and double sheet bend
     o Cat’s paw
     o Scaffold hitch
     o Trucker’s hitch
     o Timber hitch

3. Select, inspect and use wire rope
   • Types and usage
     o Fibre core
     o Hard core
   • Rejection criteria
   • Construction
   • Maintenance and storage
   • Design factors (working load limit)

4. Select, inspect and use slings
   • Fibre rope
   • Wire rope
LEARNING TASKS

5. Select, inspect and use rigging attachments

CONTENT

- Chain
- Fibre mesh
- Synthetic fibre web
- Wire mesh
- Maintenance and storage
- Spreader bars
- Eye bolts
- Hoist rings
- Shackles
- Hooks
- End terminations
- Turnbuckles
- Blocks and pulleys
- Rejection criteria
- Maintenance and storage

Achievement Criteria

Performance The learner will be able to tie knots per application.

Conditions The learner will be given:
- Classroom or shop setting
- Rope
- Instructions

Criteria The learner will be evaluated on:
- Safety
- Correct knot for application
Line (GAC): G PERFORM RIGGING, HOISTING/LIFTING AND MOVING
Competency: G2 Select and use hoisting and lifting equipment

Objectives

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

• Identify and use hand rigging and devices.
• Identify and describe cranes.

LEARNING TASKS

1. Describe jurisdictional regulations

   • Responsibilities of
     o WorkSafeBC
     o Employer
     o Employee
   • Inspection requirements
     o Annual
     o Pre-use
   • Company specific requirement’s (risk assessment)
   • Manufacturers’ specifications

2. Select, inspect and use hand rigging equipment

   • Storage and protection
   • Data plates (tags)
   • Replacement
   • WCB regulations
     o Hand signals
   • Types of hand rigging equipment
     o Jacks
     o Come-a-longs
     o Tirfors
     o Chain hoists
     o Winches
   • Rejection criteria
   • Maintenance and storage

3. Describe the use of cranes

   • Types of cranes
     o Overhead
     o Conventional
     o Mobile Hydraulic
     o Tower
     o Boom trucks
     o Jib
     o Gantry
     o Hydraulic hoist
   • Jurisdictional regulations
     o Hand signals
   • Read and interpret load chart
   • Pre-use inspection
LEARNING TASKS

CONTENT
- Fuel levels
- Tire pressure
- Absence of leaks
- Set up cranes
  - Load ratings for boom angles and distance
  - Floats under outriggers
    - Cribbing and dunnage

Achievement Criteria

Performance  The learner will be able to create a rigging plan.
Conditions   The learner will be given:
  - PPE
  - Lifting scenario
Criteria      The learner will be evaluated on:
  - Safety
  - Written rigging plan
    - Determine weight
    - Centre of gravity/WLL
    - Rigging attachments
    - Selection and application of rigging equipment
    - Hand signals
Line (GAC): G

Perform Rigging, Hoisting/Lifting and Moving

Competency: G3 Create a rigging plan

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

- Perform rigging calculations.
- Create a rigging plan.

Learning Tasks

1. Describe jurisdictional regulations
   - Responsibilities of WorkSafeBC, Employer, Employee
   - Inspection requirements: Annual, Pre-use
   - Company specific requirements (risk assessment)
   - Manufacturers’ specifications

2. Perform rigging calculations
   - Load: Formulae, Scale/load cells, Dynamometers, Name plate, Manufacturer’s manual
   - Sling stress
   - Working Load Limit (WLL): Fibre rope, Wire rope, Slings, Eye bolt
   - Safety factors

3. Create a rigging plan
   - Safety requirements
   - PPE requirements
   - Establish communication: Line of sight/hand signals, Two-way radio
   - Read and interpret load charts
   - Sling angles
   - Centre of gravity
   - Stability triangle
   - Transporting equipment
   - Secure lift radius
Program Content
Level 1

LEARNING TASKS

CONTENT
- Weather and ground conditions
- Site evaluation
- Post inspection
Level 2

Industrial Mechanic (Millwright)
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency:  C1  Use mathematics and science

Objectives
To be competent in this area, the individual must be able to:
• Use fits and tolerances.
• Use trigonometry.
• Use simple machines.
• Use power transmission theory.

LEARNING TASKS
1. Solve problems dealing with solids
   • Geometric shapes
     o Prisms
     o Cones
     o Pyramids
     o Spheres
   • Lateral surface area
     o Prisms
     o Cones
     o Pyramids

2. Solve problems using trigonometry
   • Relationship of functions
     o Sine
     o Cosine
     o Tangent
   • Trigonometry
     o Sine
     o Cosine
     o Tangent

3. Use graphs and tables to solve problems
   • Terminology
     o Charts
     o Tables
     o Graphs
   • Graph, chart and table interpretation

4. Describe the properties and calculate the strength of materials
   • Terminology
     o Tensile strength
     o Shear strength
     o Compressive strength
     o Bearing load
   • Strength calculation

5. Calculate work and power
   • Terminology
     o Work
     o Power
     o Horsepower
     o Brake horsepower
   • Metric and imperial unit conversion
LEARNING TASKS

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

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

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

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

10. Identify and use simple machines
    - Classes of levers
    - Wheels and axles
    - Pulleys
    - Inclined planes
    - Screw
      - Jack
      - Bolt
    - Compound machines

11. Describe problems involving forces associated with simple machines
    - Turning moments
    - Mechanical advantage
    - Distributed loads
    - Acceleration
    - Velocity

12. Explain the theory and perform calculations related to power
    - Speed
    - Torque
    - Horsepower
    - Ratios
    - Force

13. Explain and perform calculations related to power transmission and motion

CONTENT

• Calculations
  - Work
  - Power
  - Horsepower
  - Brake horsepower

• Bilateral
• Unilateral
• Basic hole system
• Basic shaft system

• Locational
• Interference
• Clearance
• Transition
• Running

• Expansion
• Shrink
• Force

• Check for run-out
• Concentricity
• Parallelism
• Angularity

• Classes of levers
• Wheels and axles
• Pulleys
• Inclined planes
• Screw
  - Jack
  - Bolt
• Compound machines

• Turning moments
• Mechanical advantage
• Distributed loads
• Acceleration
• Velocity

• Speed
• Torque
• Horsepower
• Ratios
• Force
LEARNING TASKS
control systems

CONTENT

- 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): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C3  Lubricate systems and components

Objectives
To be competent in this area, the individual must be able to:
- Select the correct lubricant for specific applications.
- Describe the safe use, storage and handling of lubricants.
- Identify types of lubricating systems.
- Describe maintenance and service of lubricating systems.

LEARNING TASKS
1. Describe types of friction

   CONTENT
   - Types of friction
     o Rolling
     o Sliding
     o Fluid
     o Starting
   - Causes of friction
   - Effects of friction

2. Describe oil lubrication

   CONTENT
   - Oil wedge theory
   - Boundary
   - Full film

3. Describe types and properties of lubricants

   CONTENT
   - Types of lubricants
     o Grease
     o Oil
     o Synthetic oils
   - Properties and characteristics of grease
     o Additives
     o Soap
     o Non-soap
     o Multi-grease
       - Multi-purpose grease
       - Extreme pressure grease
     o Mixed soap
     o Grades
     o Polar attraction
     o Directional fluidity
     o Selection process
     o Compatibility
   - Properties and characteristics of oil
     o Viscosity
       - Kinematics
       - Dynamic
       - Index
     o Grading systems
     o Additives
     o Inhibitors
### LEARNING TASKS

4. Select lubricants for specific purposes

5. Describe handling procedures

6. Describe various lubrication systems

7. Maintain lubrication systems

### CONTENT

- **Classifications**
  - **Oil**
    - Advantages
    - Disadvantages
  - **Grease**
    - Advantages
    - Disadvantages

- **Safe handling**
- **WHMIS 2015**
- **Storage**
- **Automatic**
- **Pressure**
- **Gravity**
- **Reservoir**
- **Splash**
- **Flinger**
- **Manual**
- **Capillary**
- **Injector**

- **Inspection procedures**
- **Lubricant problem diagnosis**
  - Visual
  - Smell
  - Feel
  - Chemical analysis
- **Tribology**
- **Cleaning system**
- **Lubricant disposal**
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C4  Perform leveling of components and systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the leveling and alignment of components.

LEARNING TASKS
1. Describe the leveling and alignment of components

CONTENT
• Shafts
• Clutches
• Belts
• Chains
• Gears
Program Content
Level 2

Line (GAC):   C   PERFORM ROUTINE TRADE ACTIVITIES
Competency:   C7  Perform material identification

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 non-ferrous metals, using appropriate trade terminology.

LEARNING TASKS

1. Identify common metals

   CONTENT
   • Define terms
     o Ductility
     o Malleability
     o Toughness
     o Brittleness
   • Identification methods
     o Non-destructive testing
       – Dye penetration
       – UV lights
     o Mechanical testing
       – Spark
       – File
       – Chisel
       – Hardness
       – Impact
       – Ultrasonic thickness
     o Chemical testing
       – Acid
       – Caustic
   • Manufacturing process of iron and steel
     o Smelting
     o Refining
   • Methods and manufacture
     o Forging
     o Casting
     o Rolling

2. Identify properties of metals

   • Tension
   • Compression
   • Torsion
   • Bending
   • Shearing
   • Safe load
   • Elastic limit
   • Yield point
   • Failure point
**LEARNING TASKS**

3. Describe the metallurgical properties of non-ferrous metals

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

**CONTENT**

- Aluminum
- Copper
- Brass
- Bronze
- Stainless steel
- Chrome alloys
- Manganese
- Titanium
- Rubber
- Plastics
- Epoxy resins
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C8 Perform heat treatment of metal

Objectives
To be competent in this area, the individual must be able to:
• Describe the metallurgical principles of ferrous metals using appropriate trade terminology.

LEARNING TASKS
1. Describe the metallurgical principles of ferrous metals
   • Terminology
     o Heat treatment
     o Upper critical temperature
     o Lower critical temperature
     o Critical range
     o Hardening
     o Case hardening
     o Tempering
     o Annealing
     o Normalizing
     o Pearlite
     o Ferrite
     o Cementite
     o Austenite
     o Martensite
   • Hardening and tempering steels
     o Preparation
     o Heat and molecular changes
     o Oxidation
   • Failure causes
     o Fatigue
     o Oxidation
     o Stress cracking
     o Corrosion
     o Brittleness

2. Perform heat treatment of metal
   • Ovens and forges
   • Contaminant removal
   • Hardening
   • Tempering
   • Descale

Achievement Criteria
Performance The learner will be able to harden and temper tool steel.
Conditions The learner will be given:
• PPE
• Heating equipment
• Work area – properly ventilated
• Material
• Drawing with specifications
• Tools

Criteria

The learner will be evaluated on:

• Safety
• Safe set up and use of heating equipment
• Accuracy according to drawing
• Hardness to specifications
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C9 Use mechanical drawings and specifications

Objectives
To be competent in this area, the individual must be able to:
• Describe drawings used to assemble machines.

LEARNING TASKS
1. Describe how to assemble machines using drawings

CONTENT
• Drawings
• Engineering prints
• CADD
Line (GAC): F PERFORM CUTTING AND WELDING OPERATIONS
Competency: F2 Weld material using shielded arc welding equipment (SMAW)

Objectives
To be competent in this area, the individual must be able to:
- Perform shielded metal arc welding.
- Maintain shielded metal arc welding equipment.
- Perform vertical shielded metal arc welding.

LEARNING TASKS
1. Explain the principles of electricity and its application to shielded metal arc welding
   - Basic principles of electricity
   - Types of current
     - Applications
   - AC/DC welding
   - Associated equipment
     - Electrode holders
     - Ground clamps
     - Cables
   - Electrodes
     - SMAW electrodes
     - Handling and storage
     - Application selection

2. Describe shielded metal arc welding equipment
   - Set up
   - Amperage adjustment
   - Polarity selection
   - Basic joint design
   - Weld types, sizes and profiles
   - Welding positions
     - Flat
     - Horizontal
     - Vertical
     - Overhead
   - Weld faults
     - Undercuts
     - Porosity
     - Inclusions
     - Voids
   - Distortion control methods
   - Maintenance procedures
     - Stinger
     - Cables
     - Clamps
     - Plugs
     - Safety devices
LEARNING TASKS

4. Describe vertical shielded metal arc welding equipment

5. Perform vertical shielded metal arc welding

CONTENT

- Shut down
- Associated equipment
  - Electrode holders
  - Ground clamps
  - Cables
- Electrodes
  - Correct handling and storage
  - Select for specific application
- Set up
  - Unsafe SMAW equipment identification
- Basic joint design
- Weld types, sizes and profiles
- Vertical welding positions
- Weld faults
  - Undercuts
  - Porosity
  - Inclusions
  - Voids
- Distortion control methods
  - Fit
- Shut down

Achievement Criteria

Performance The learner will be able to perform SMAW procedures.

Conditions The learner will be given:
- PPE
- Welding equipment
- Work area – properly ventilated
- Material
- Tools
- Task instructions

Criteria The learner will be evaluated on:
- Safety
- Safe set up and use of welding equipment
- Stress test
Line (GAC): F PERFORM CUTTING AND WELDING OPERATIONS
Competency: F3 Weld material with gas metal arc welding equipment (GMAW)

Objectives
To be competent in this area, the individual must be able to:
• Identify gas metal arc welding (GMAW or MIG) equipment.
• Perform gas metal arc welding.
• Maintain gas metal arc welding (GMAW or MIG) equipment

LEARNING TASKS
1. Explain principles of Gas Metal Arc Welding (GMAW) and / or Metal Inert Gas Welding (MIG)
   • Principles of operation
   • Modes of metal transfer
   • Hard surfacing
   • Power sources
   • Wire feed system
     o Wire feed and speed
     o Amperage
   • Shielding gases
   • Gun assemblies
   • Equipment set up
   • Wire types and sizes
   • Set up
   • Maintenance
2. Identify, set up and maintain welding equipment
   • 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
   • Distortion control methods
   • Shut down
3. Describe theory and perform basic welding

Achievement Criteria
Performance The learner will be able to perform GMAW procedures.
Conditions The learner will be given:
• PPE
Program Content
Level 2

- Welding equipment
- Work area – properly ventilated
- Material
- Tools
- Task instructions

Criteria

The learner will be evaluated on:

- Safety
- Safe set up and use of welding equipment
- Stress test
Program Content
Level 2

Line (GAC): F PERFORM CUTTING AND WELDING OPERATIONS
Competency: F4 Weld material with gas tungsten arc welding equipment (GTAW)

Objectives
To be competent in this area, the individual must be able to:
• Identify gas tungsten arc welding (GTAW / TIG) equipment.
• Describe gas tungsten arc welding.
• Maintain gas tungsten arc welding (GTAW / TIG) equipment.

LEARNING TASKS

1. Explain principles of Gas Tungsten Arc Welding (GTAW / TIG)
   • Principles of operation
   • Modes of metal transfer
   • Hard surfacing
   • Power sources
   • Wire feed system
     o Wire feed and speed
     o Amperage
   • Shielding gases
   • Gun assemblies
   • Equipment set up
   • Wire
     o Types
     o Sizes
   • Set up
   • Maintenance

2. Identify, set up and maintain welding equipment
   • 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
   • Distortion control methods
   • Shut down

3. Describe theory of basic welding
Line (GAC): H SERVICE SHAFTS, BEARINGS AND SEALS
Competency: H1 Select, install and maintain shafts

Objectives
To be competent in this area, the individual must be able to:
• Install and fit keys, key ways and key seats.
• Describe the service of shafts and shaft attachments.

LEARNING TASKS
1. Install keys, key ways and key seats
   CONTENT
   • Types
     o Keys
     o Key seats/key ways
     o Taper keys
   • Uses
   • Standard sizes
   • Set screws
   • Procedures
     o Selection of keys
     o Key seats and key ways cutting
       – Portable milling machines
       – Broach and arbor press
     o Removal
     o Installation
     o Fitting
     o Securing

2. Describe the service of shafts and shaft attachments
   • Terminology
   • Shaft types
     o Drive
     o Counter
     o Jack
     o Hollow
   • Shafting
     o Types
     o Uses
     o Sizes
     o Identification
     o Stresses
       – Types
       – Source
       – Reduction
       – Bearing placement
       – Maintenance
       – Shaft repair methods
         • Straightening
         • Spray welding
   • Attachments
LEARNING TASKS

CONTENT

- 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 able to cut a key seat, fit a key and install a hub.

Conditions The learner will be given:

- PPE
- Material
- Tools
- Work bench
- Portable key seat cutter
- Milling machine
- Drawing
- Machinery handbook

Criteria The learner will be evaluated on:

- Safety
- Accuracy
Program Content
Level 2

Line (GAC): H SERVICE SHAFTS, BEARINGS AND SEALS
Competency: H2 Select, install and maintain 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.
- Fit, mount and dismount friction and anti-friction bearings.
- Inspect and maintain bearings and diagnose causes of bearing failures.

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
LEARNING TASKS

4. Describe anti-friction bearings

5. Select bearings based on application

6. Install and remove friction bearings

CONTENT

- Brass
- Silver
- Cast iron
- New alloys
  - Non-metallic
    - Nylon
    - Phenolic plastic
    - Polyurethane
    - Wood
    - Advanced plastics
  - Liner material characteristics
    - Embed ability
    - Score resistance
    - Fatigue resistance
    - Conformability
    - Compatibility
    - Abrasion resistance

- 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

- Bearing codes

- Friction

- Anti-friction

- Fitting methods
  - Hand scraping
  - Machine fitting
  - Hydraulic assist
  - Bluing

- Clearance requirements
  - Installed
  - Running
LEARNING TASKS

7. Perform inspection and maintenance procedures on friction bearings

8. Install and remove anti-friction bearings

CONTENT

- Plastigauge®
- Lead wire
- Positioning methods
  - Fixed
  - Floating
  - Locking rings
  - Hydraulic nut
  - Arbour press
- Lubrication
  - Styles and position of lubrication grooves
  - Lubrication methods
  - Types of lubrication
- Inspection
  - Visual
  - Sound
  - Temperature
  - Vibration
  - Lubrication
- Repair methods
  - Liner material
  - Shafts
  - Housings
- Fits and tolerances
  - Dimensions
  - Unilateral and bilateral
  - Limit of size
  - Allowance
  - Radial and axial clearance
  - Pre-load
- Allowances
  - Expansion fits
  - Shrink fits
- Fit table applications
- Fitting procedures
  - 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
LEARNING TASKS

9. Perform inspection and maintenance procedures on anti-friction bearings

CONTENT

- Lubrication
  - Types
  - Methods
    - Initial
    - Running

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

- Bearing problem diagnosis
  - Oil discolouration
  - Load distribution
  - Spalling
  - Galling
  - Brinnelling
  - False brinnelling
  - Vibration analysis
  - Alignment
  - Monitoring equipment

Achievement Criteria

Performance The learner will be able to remove and install bearings.

Conditions The learner will be given:
- PPE
- Components
- Tools
  - Induction heater
  - Temperature sensing equipment
- Work bench
- Machinery handbook

Criteria The learner will be evaluated on:
- Safety
- Cleanliness
- Correct application
- Fit and clearances
Line (GAC): H  SERVICE SHAFTS, BEARINGS AND SEALS
Competency: H3  Select, install and maintain seals

Objectives

To be competent in this area, the individual must be able to:
- Select the correct seals, packing and gaskets to meet specific applications.
- Describe the installation, removal and maintenance of seals.

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

LEARNING TASKS

6. Select seals, gaskets and packing

7. Describe seal installation and maintenance procedures

CONTENT

- Others
  - Non-contact
    - Labyrinth
    - Annulus
    - Grease injected
    - Others
  - Seals
  - Packing
  - Gaskets
  - Compatibility
  - Stamping (sizing)
  - Piston rings
    - Material
    - Installation
    - Measurement (inspection)
  - Lip seals
    - Material
    - Installation
    - Inspection
    - Removal
  - Rod wipers
    - Types
    - Installation
    - Inspection
    - Removal
  - Mechanical seals
    - Installation
    - Inspection
    - Removal
    - Maintenance
  - Packing installation and maintenance
    - Selection
    - Rings
    - V-packing
    - U-section packing
    - Cup packing
    - Jam packing
    - “O” rings
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
   - Purpose
     - Rigid
     - Flexible
   - 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

2. Maintain couplings
   - Installation procedures
   - Removal procedures
   - Assembly and alignment
   - Maintenance
     - Flexible
     - Rigid
   - Diagnosis
LEARNING TASKS

CONTENT

- Failures
- Causes of failure
  - Misalignment
  - Incorrect assembly
  - Lack of lubrication
- Troubleshooting
  - Wear
  - Noise
  - Strobe light
Line (GAC): SERVICE COUPLINGS, CLUTCHES AND BRAKES
Competency: I2 Select, install and maintain clutches and brakes

Objectives
To be competent in this area, the individual must be able to:
• Inspect clutches and brakes.

LEARNING TASKS

1. Describe clutches and brakes
   • Construction and operation
     o Mechanical
       – Rigid
       – Flexible
       – Positive
       – Friction
       – Overrunning
     o Fluid
       – Hydraulic
       – Lead shot
     o Pneumatic
       – Disc
       – Drum
     o Electrical
       – Disc
       – Drum
       – Band

2. Inspect clutches
   • Selection for applications
     o Load
     o Speed
     o Directional requirements
   • Clutches used as brakes
   • Safety requirements
   • Procedures
     o Inspection
     o Installation
     o Removal
     o Testing
     o Strobe light

3. Inspect brakes
   • Safety requirements
   • Procedures
     o Inspection
     o Installation
     o Removal
     o Testing
     o Intermittent
     o Continuously running
Line (GAC): J  SERVICE CHAIN AND BELT DRIVE SYSTEMS
Competency: J1  Select, install and maintain chain drive systems

Objectives
To be competent in this area, the individual must be able to:
•  Describe drive chains.

LEARNING TASKS
1.  Describe drive chains

CONTENT
• Terminology
  o  Roller link
  o  Plate link
  o  Offset link
  o  ANSI
  o  ISO
  o  Chain codes
  o  Bushing
  o  Sprocket
  o  Slack
  o  Idler
  o  Pitch
  o  Multiple pitch
LEARNING TASKS
2. Describe chain drive assembly

CONTENT
- Drive chain types
  - Standard
  - Roller less
  - Heavy series
  - Light weight
  - Multiple strand
  - Double pitch
  - Self-lubricated
  - Silent
  - Engineered chain
  - H-class or pintle
- Uses
  - Function or purpose
  - Chain service
  - Selection
  - Application
- Sprockets
  - Types
  - Identification
  - Selection
  - Application
  - Installation
  - Removal
- Chain drive problem calculations
  - Speeds
  - Chain lengths
  - Sprocket sizes
  - Center distance
  - Chain Slack
  - Tension requirements
- Horsepower/torque requirements
LEARNING TASKS
3. Inspect, install and maintain chain drives

CONTENT
- Drive chain assembly
  - Design
    - Arrangement
    - Factors
    - Advantages and disadvantages
  - Tensioning devices
  - Alignment
    - Sprockets
    - Shafts
    - Drive assembly
  - Chain joining
  - Lubrication
- Safety requirements
- Drive inspection
- Troubleshooting
- Lubrication
- Alignment
- Sprocket installation
- Chain replacement
- Installation

Achievement Criteria
Performance The learner will be able to install and align chain drives.
Conditions The learner will be given:
  - PPE
  - Components
  - Tools
  - Work bench
  - Reference resources
Criteria The learner will be evaluated on:
  - Safety
  - Cleanliness
  - Accuracy
  - Machine tolerances
  - Correct assembly
    - Slack
Line (GAC): J  SERVICE CHAIN AND BELT DRIVE SYSTEMS
Competency: J2  Select, install and maintain belt drive systems

Objectives
To be competent in this area, the individual must be able to:
• Define belt drive terminology.
• Identify types and arrangements of belt drive systems.
• Install and service belt drive systems.

LEARNING TASKS
1. Describe belt drives

CONTENT
• 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

  • Belt drive operation principles
    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

2. Describe flat belt drive systems

• Belts
  o Types
    – Positive drive
    – Leather
    – Serpentine
  o Identification
  o Construction
  o Joining
LEARNING TASKS

3. Describe V-belt drive systems

4. Perform belt drive calculations

5. Install and maintain belt drives

CONTENT

- Vulcanized
- Mechanical fasteners
- Splicing
  - Storage
- Sheaves
  - Construction and shape
  - Diameters
    - Belt life
    - Rim speed
  - Materials
  - Mounting
  - Speed calculations
  - Effects of pitch diameter on belts
  - Idler shafts
  - Specifications
  - Applications
  - Selection crowning
  - Coned pulleys
- Types of V-belts
  - Link
  - Notched
  - Variable speed belts
  - Power band belts
  - Double V
  - Conventional
  - Serpentine
- V-belt construction
- V-belt storage
- Pulleys
  - Construction
  - Size calculations
  - Relationship between size and belt speed
  - Application
  - Specifications
  - Selection
- Speeds
  - Ratios
  - Simple reductions
  - Compound reductions
  - Belt velocity
  - RPM
- Belt installation
  - Arc of contact
  - Belt length
  - Tension
  - Center distance
- Drive installation
  - Alignment
LEARNING TASKS

6. Describe variable speed drives

7. Maintain variable speed drives

CONTENT

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

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

- 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

Achievement Criteria

Performance The learner will be able to install and align belt drives.

Conditions The learner will be given:
  - PPE
  - Components
  - Tools
  - Work bench
  - Reference resources

Criteria The learner will be evaluated on:
  - Safety
- Cleanliness
- Accuracy
- Machine tolerances
- Correct assembly
  - Tension
Line (GAC): K  SERVICE GEAR SYSTEMS
Competency: K1  Select and install gear systems

Objectives
To be competent in this area, the individual must be able to:
• Describe gear terminology.
• Identify types and arrangements of gears and gear drives.

LEARNING TASKS
1. Describe gear terminology
   • 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 and identify characteristics 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
  - Diametrical pitch
  - Pitch diameter
  - Outside diameter
  - Center distance
  - Addendum
  - Dedendum

- Speed and ratio calculations
  - Simple gear drives
  - Compound gear drive
Line (GAC): K SERVICE GEAR SYSTEMS
Competency: K2 Diagnose, maintain and repair gear systems

Objectives
To be competent in this area, the individual must be able to:
• Inspect and repair gear drives.

LEARNING TASKS
1. Describe gear drives and reduction units
   • Identification
     o Types
     o Hand
   • Installation
     o Mounting
       − Alignment
       − Permanent location
       − Shaft mounted
     o Attachments
     o Assembly
     o Inspection
   • Lubrication
     o Methods
     o Inspection
   • Bearings
     o Types
     o End float
     o Clearance
   • Seals
     o Location
     o Installation
   • Safety
     o Precautions
     o Guards
   • Inspection
     o Reduction unit dismantling
     o Dowels
     o Noise
     o Vibration
     o Heat
     o Lubrication
     o Wear patterns
     o Backlash
     o Effects
       − Bearings
       − Seals
     • Gear mesh
       o Backlash

2. Inspection of gear drives
   • Safety
     o Precautions
     o Guards
   • Inspection
     o Reduction unit dismantling
     o Dowels
     o Noise
     o Vibration
     o Heat
     o Lubrication
     o Wear patterns
     o Backlash
     o Effects
       − Bearings
       − Seals
   • Gear mesh
     o Backlash
## LEARNING TASKS

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Gear contact</td>
</tr>
<tr>
<td>• Wear patterns</td>
</tr>
</tbody>
</table>

### Achievement Criteria

<table>
<thead>
<tr>
<th>Performance</th>
<th>The learner will be able to disassemble and assemble gear/boxes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions</td>
<td>The learner will be given:</td>
</tr>
<tr>
<td></td>
<td>• PPE</td>
</tr>
<tr>
<td></td>
<td>• Components</td>
</tr>
<tr>
<td></td>
<td>• Tools</td>
</tr>
<tr>
<td></td>
<td>• Work bench</td>
</tr>
<tr>
<td></td>
<td>• Reference resources</td>
</tr>
<tr>
<td>Criteria</td>
<td>The learner will be evaluated on:</td>
</tr>
<tr>
<td></td>
<td>• Safety</td>
</tr>
<tr>
<td></td>
<td>• Cleanliness</td>
</tr>
<tr>
<td></td>
<td>• Correct assembly</td>
</tr>
<tr>
<td></td>
<td>• Fit and clearances</td>
</tr>
</tbody>
</table>
Program Content
Level 2

Line (GAC): L PERFORM SHAFT ALIGNMENT PROCEDURES
Competency: L1 Perform rough alignment

Objectives
To be competent in this area, the individual must be able to:
• Describe shaft alignment procedures.
• Use shaft alignment tools.
• Demonstrate shaft alignment procedures.
• Record shaft alignment results.

LEARNING TASKS
CONTENT
1. Describe rough alignment tools
   • Straight edge
   • Gauge
     o Taper
     o Feeler
   • Shims
   • Calipers
     o Inside
     o Outside

2. Describe types of misalignment and corrections
   • Types of misalignment
     o Angular
     o Offset
     o Combination
     o Deliberate

3. Describe pre-alignment procedures
   • Base integrity
   • Run out
   • Soft foot
   • Couplings

4. Describe alignment procedures for rough alignment
   • Equipment alignment procedures
     o Alignment tools
     o Shims
     o Jacking screws

5. Use equipment alignment procedures
   • Alignment equipment
     o Various types
     o Selection
     o Checking and maintaining
     o Care
     o Mounting
     o Shims
     o Jacking screws
   • Machine component procedures
     o Rolls
     o Hubs
     o Bearings
LEARNING TASKS

CONTENT

- Sprockets
- Sheaves
**Program Content**
*Level 2*

**Line (GAC):**   L  
**Competency:**   L2  
**PERFORM SHAFT ALIGNMENT PROCEDURES**

**Objectives**
To be competent in this area, the individual must be able to:
- Perform rim and face dial alignment.

**LEARNING TASKS**

1. **Describe rim and face alignment tools**
   - Dial indicators
   - Dial brackets
   - Straight edge
   - Gauge
     - Taper
     - Feeler
   - Shims
   - Micrometers
     - Inside
     - Outside
   - Tape measure
   - Mirror

2. **Describe types of misalignment and how to correct them**
   - Types of misalignment
     - Angular
     - Offset
     - Combination
     - Deliberate

3. **Describe pre-alignment procedures**
   - Base integrity
   - Run out
   - Soft foot
   - Couplings

4. **Demonstrate alignment procedures for rim and face alignment**
   - Alignment formulae
   - Procedures for equipment alignment
     - Alignment tools
     - Shims
     - Jacking screws

5. **Use equipment alignment procedures**
   - Alignment equipment
     - Types
     - Selection
     - Checking and maintaining
     - Care
     - Mounting
     - Shims
     - Jacking screws
   - Machine component procedures
LEARNING TASKS

6. Demonstrate alignment procedures and record keeping

CONTENT
- Rolls
- Hubs
- Bearings
- Sprockets
- Sheaves

- Procedures
  - Soft foot
  - Rough alignment
  - Rim and face

- Maintenance records

Achievement Criteria

Performance  The learner will be able to align shafts.

Conditions  The learner will be given:
  - PPE
  - Components
  - Tools
  - Work bench
  - Reference resources

Criteria  The learner will be evaluated on:
  - Safety
  - Cleanliness
  - Accuracy
  - Machine tolerances
  - Correct assembly
Level 3

Industrial Mechanic (Millwright)
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C1 Use mathematics and science

Objectives
To be competent in this area, the individual must be able to:
• Describe fluid power theory.
• Use fluid power calculations.

LEARNING TASKS
1. Describe the theory of compressed gasses
   • Terms and Laws
     o Pascal’s Law
     o Boyle’s Law
     o Charles’ Law
     o Torricelli’s Principle
     o Vacuum and pressure scales
     o Temperature scales
     o Atmospheric pressure
     o Heat of compression
     o Flow rate
   • Energy transmission
     o Heat energy
     o Pressure energy
   • Air compression
     o Adiabatic
     o Isothermal

2. Explain the application of compressor theory
   • Gas laws
   • Compressor operation
   • Compression ratios

3. Describe the principles of vacuum
   • Terminology
     o Vacuum
     o Negative pressure
     o Atmospheric pressure
     o Suction
   • Laws and Principles
     o Pascal’s Law
     o Bernoulli’s Principle
     o Ideal gas laws

4. Describe the principles of fluid power
   • Laws and Principles
     o Pascal’s Law
     o Bernoulli’s Principle
     o Newton’s Law of conservation of energy
     o Multiplication forces
   • Terminology
     o Hydrodynamic
LEARNING TASKS

5. Explain the relationship of flow and flow paths

6. Use fluid power calculations

CONTENT

- Hydrostatic
- Atmospheric pressure
- Suction
- Head
- Cavitation
- Lift
- Vacuum and pressure measurements
- Input-output components
- Advantages and disadvantages
  - Hydraulics vs. other power sources

- Fluid flow
- Creation of pressure
- Series flow paths
- Parallel flow paths
- Pressure drop
- Laminar and turbulent flow
- Pneumatic
- Hydraulic
- Vacuum
Level 3

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C4 Perform leveling of components and systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the leveling and alignment of machine components.

LEARNING TASKS
1. Describe the leveling and alignment of components

CONTENT
• Fans
• Blowers
• Pumps
• Compressors
• Pipes and tanks
• Hydraulic
• Vacuum
• Pneumatic
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C9 Use mechanical drawings and specifications

Objectives
To be competent in this area, the individual must be able to:
• Identify and use schematic and graphical symbols used in hydraulic and pneumatic circuitry as it pertains to JIC and ISO standards.
• Identify and interpret the symbols used on vacuum system drawings.

LEARNING TASKS
1. Identify and use hydraulic schematic symbols
   • Standard graphic symbols
     o JIC (Joint Industry Conference)
     o ANSI (American National Standards Association)
     o ISO (International Standards Organization)

2. Identify and use pneumatic schematic symbols
   • Standard graphic symbols
     o JIC (ANSI)
     o ISO

3. Identify the symbols associated with vacuum systems and interpret their meaning
   • ISO
   • JIC (ANSI)
Program Content
Level 3

Line (GAC): L   PERFORM SHAFT ALIGNMENT PROCEDURES
Competency: L2  Perform dial alignment procedures

Objectives
To be competent in this area, the individual must be able to:
• Perform complex dial alignment.

LEARNING TASKS

1. Describe cross dial and graph alignment tools
   • Dial indicators
   • Dial brackets
   • Straight edge
   • Gauge
     o Taper
     o Feeler
   • Shims
   • Micrometers
     o Inside
     o Outside
   • Tape measure
   • Mirror
   • Graph paper

2. Describe types of misalignment and how to correct them
   • Types of misalignment
     o Angular
     o Offset
     o Combination
     o Deliberate

3. Describe pre-alignment procedures
   • Base integrity
   • Run out
   • Soft foot
   • Couplings

4. Demonstrate alignment procedures for cross dial and graph alignment
   • Alignment formulae
   • Graph and plot
   • Equipment alignment procedures
     o Alignment tools
     o Shims
     o Jacking screws

5. Use equipment alignment procedures
   • Alignment equipment
     o Various types
     o Selection
     o Checking and maintaining
     o Care
     o Mounting
     o Shims
LEARNING TASKS

6. Demonstrate alignment procedures and record keeping

CONTENT
- Jacking screws
- Machine component procedures
  - Rough alignment
  - Rolls
  - Hubs
  - Bearings
  - Sprockets
  - Sheaves
- Procedures
  - Reverse reading
  - Graph alignment
- Maintenance records

Achievement Criteria

Performance The learner will be able to align shafts.

Conditions The learner will be given:
- PPE
- Components
- Tools
- Work bench
- Reference resources

Criteria The learner will be evaluated on:
- Safety
- Cleanliness
- Accuracy
- Machine tolerances
- Correct assembly
Line (GAC): L PERFORM SHAFT ALIGNMENT PROCEDURES
Competency: L3 Perform laser alignment

Objectives
To be competent in this area, the individual must be able to:
• Perform laser alignment.

LEARNING TASKS

1. Describe laser alignment tools
   • Laser
   • Brackets
   • Straight edge
   • Gauge
     o Taper
     o Feeler
   • Shims
   • Micrometer
   • Tape measure

2. Describe types of misalignment and how to correct them
   • Types of misalignment
     o Angular
     o Offset
     o Combination
     o Deliberate

3. Describe pre-alignment procedures
   • Base integrity
   • Run out
   • Soft foot
   • Couplings

4. Demonstrate alignment procedures for laser alignment
   • Equipment alignment procedures
     o Alignment tools
     o Shims
     o Jacking screws

5. Use equipment alignment procedures
   • Alignment equipment
     o Various types
     o Selection
     o Checking and maintaining
     o Care
     o Mounting
     o Shims
     o Jacking screws
   • Machine component procedures
     o Rough alignment
     o Rolls
     o Hubs
     o Bearings
     o Sprockets
LEARNING TASKS

6. Demonstrate alignment procedures and record keeping

CONTENT

- Sheaves
  - Procedures
  - Maintenance records

Achievement Criteria

Performance The learner will be able to align shafts using laser equipment.

Conditions The learner will be given:

- PPE
- Components
- Tools
- Work bench
- Reference resources

Criteria The learner will be evaluated on:

- Safety
- Cleanliness
- Accuracy
- Machine tolerances
- Correct assembly
Line (GAC): M SERVICE FANS AND BLOWERS
Competency: M1 Select, install and maintain fans

Objectives
To be competent in this area, the individual must be able to:
- Describe the maintenance and service of fans.

LEARNING TASKS

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>LEARNING TASKS</th>
</tr>
</thead>
</table>
| 1. Describe classifications and types of fans and fan systems | - Classification of fans  
| |   - Axial  
| |   - Centrifugal  
| |   - Axial flow  
| |   - Free flow  
| |   - Ducted  
| |   - Vane  
| |   - Centrifugal flow  
| |   - Radial  
| |   - Air foil  
| |   - Forward curved  
| |   - Backward curved  
| | - Induction, balanced and forced draft  
| | - Safe work practices  
| | - Ventilation and pollution control  
| |   - Jurisdictional regulations  
| |   - Scrubbers  
| |   - Electrostatic precipitators  
| |   - Bag house  
| |   - Cyclonic separators  
| | - Service manuals  
| | - Specifications  
| | - Maintenance checks  
| |   - Fan blade cleaning  
| |   - Lubrication  
| |   - Alignment  
| |   - Vibration  
| |   - Wear  
| |   - Noise  
| 2. Describe the maintenance and service of fans |
Program Content
Level 3

Line (GAC): M SERVICE FANS AND BLOWERS
Competency: M2 Select, install and maintain blowers

Objectives
To be competent in this area, the individual must be able to:
• Describe the maintenance and service of blowers.

LEARNING TASKS
1. Describe types of blowers
   • Centrifugal
   • Lobe
   • Screw

2. Describe the maintenance and service of blowers
   • Safe work practices
   • Ventilation and pollution control
     o Jurisdictional regulations
     o Scrubbers
     o Electrostatic precipitators
     o Bag house
     o Cyclonic separators
   • Service manuals
   • Specifications
   • Maintenance checks
     o Alignment
     o Vibration
     o Wear
     o Noise
     o Timing
Line (GAC): N SERVICE PUMPS
Competency: N1 Identify and select positive displacement pumps

Objectives
To be competent in this area, the individual must be able to:
• Explain terminology associated with pumps.
• Describe the theory of positive displacement pump operation.
• Identify and select pumps.

LEARNING TASKS
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
   • Operating principles and basic theory
     o Positive displacement
     o Relationship of pressure and flow
     o Pump calculations
   • Styles of pumps
     o Positive displacement
     o Multi-stage
     o Single stage
     o Advantages/disadvantages/application
       – Multi stage
       – Single stage
   • Major components
     o Positive displacement
   • Application of different types of pump materials
     o Cast iron
     o Stainless steel
     o Rubber
     o Plastic
     o Exotic metals
   • Pump selection
     o Limitations
     o Condition of flow
     o Pulsation

2. Identify and select different styles of pumps
LEARNING TASKS

CONTENT

- Structural considerations
- Products pumped
  - Hydro carbons
  - Corrosives
  - Water
  - Slurries
  - Pulpy solids
  - High temperature products
Line (GAC): N SERVICE PUMPS
Competency: N2 Install, maintain and repair positive displacement pumps

Objectives
To be competent in this area, the individual must be able to:
• Describe the maintenance and service of positive displacement pumps.

LEARNING TASKS
1. Describe the installation and maintenance of positive displacement pumps
   • Specifications
     o Displacement capacity
     o Lift capacity
     o Static head
   • Install and level
     o Check rotation
   • Maintenance
     o Alignment
     o Sealing
     o Lubrication
     o Removing air

2. Describe troubleshooting 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
**Objectives**

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

- Explain terminology associated with pumps.
- Describe the theory of non-positive displacement pump operation.
- Identify and select non-positive displacement pumps.

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Describe the theory of pump operation</strong></td>
</tr>
<tr>
<td>1. <strong>Terminology</strong></td>
</tr>
<tr>
<td>- Static</td>
</tr>
<tr>
<td>- Suction lift</td>
</tr>
<tr>
<td>- Discharge head</td>
</tr>
<tr>
<td>- Suction head</td>
</tr>
<tr>
<td>- Dynamic</td>
</tr>
<tr>
<td>- Suction lift</td>
</tr>
<tr>
<td>- Discharge head</td>
</tr>
<tr>
<td>- Suction head</td>
</tr>
<tr>
<td>- Total head</td>
</tr>
<tr>
<td>- Cavitation</td>
</tr>
<tr>
<td>- Non-positive displacement</td>
</tr>
<tr>
<td>2. <strong>Operating principles and basic theory</strong></td>
</tr>
<tr>
<td>- Non-positive displacement</td>
</tr>
<tr>
<td>- Relationship of pressure and flow</td>
</tr>
<tr>
<td>- Pump calculations</td>
</tr>
<tr>
<td>- Styles of pumps</td>
</tr>
<tr>
<td>- Non-positive displacement</td>
</tr>
<tr>
<td>- Multi-stage</td>
</tr>
<tr>
<td>- Single stage</td>
</tr>
<tr>
<td>- Advantages/disadvantages</td>
</tr>
<tr>
<td>- Multi stage</td>
</tr>
<tr>
<td>- Single stage</td>
</tr>
<tr>
<td>- Application</td>
</tr>
<tr>
<td>- Multi stage</td>
</tr>
<tr>
<td>- Single stage</td>
</tr>
<tr>
<td>- Major components</td>
</tr>
<tr>
<td>- Non-positive displacement</td>
</tr>
<tr>
<td>- Applications of pump materials</td>
</tr>
<tr>
<td>- Cast iron</td>
</tr>
<tr>
<td>- Stainless steel</td>
</tr>
<tr>
<td>- Rubber</td>
</tr>
<tr>
<td>- Plastic</td>
</tr>
<tr>
<td>- Exotic metals</td>
</tr>
<tr>
<td>- Pump selection</td>
</tr>
<tr>
<td>- Limitations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Identify and select different styles of non-positive displacement pumps</strong></td>
</tr>
</tbody>
</table>

**Program Content**

**Line (GAC):** N  SERVICE PUMPS

**Competency:** N3 Identify and select non-positive displacement pumps
LEARNING TASKS

CONTENT

- Condition of flow
- Pulsation
- Structural considerations
- Products pumped
  - Hydro carbons
  - Corrosives
  - Water
  - Slurries
  - Pulpy solids
  - High temperature products
Line (GAC): N  SERVICE PUMPS
Competency: N4  Install, maintain and repair non-positive displacement pumps

Objectives
To be competent in this area, the individual must be able to:
• Describe and perform the maintenance and service of non-positive displacement pumps.

LEARNING TASKS
1. Describe and perform maintenance of non-positive displacement pumps
   • Specifications
     o Displacement capacity
     o Lift capacity
     o Static head
   • Installation and leveling
   • Maintenance
     o Alignment
     o Sealing
     o Lubrication
     o Removing air
   • Safe work practices
   • Failure to pump
   • Cavitation
   • Air in the system
   • Leakage
   • Excessive noise
   • Excessive vibration
   • Excessive force to turn
   • Loss of discharge pressure
   • Differential pressure
   • Pump curve
   • Hot bearings
   • Internal slippage
   • Wear
   • Wear location
   • Compression packing
   • Mechanical seals
   • Lip seals
   • Volumetric efficiency

2. Describe troubleshooting non-positive displacement pumps
Achievement Criteria

Performance  The learner will be able to disassemble and assemble pumps.

Conditions  The learner will be given:
  - PPE
  - Pump
  - Components
  - Tools
  - Work bench
  - Reference resources

Criteria  The learner will be evaluated on:
  - Safety
  - Cleanliness
  - Accuracy
  - Proper removal and installation of seals
  - Machine tolerances
  - Correct assembly
Objectives

To be competent in this area, the individual must be able to:
- Identify types of compressors.
- Describe positive and non-positive displacement compressor theory.

LEARNING TASKS

1. Describe the application of compressors in industrial settings

2. Describe the major classifications of compressors

3. Identify types and styles of compressors

4. Describe positive displacement compressor theory

5. Describe non-positive displacement compressor theory

CONTENT

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

- Positive displacement
- Non-positive displacement

- Reciprocating
  - Piston
  - Free piston
  - Diaphragm
  - Cross-head
  - Trunk

- Rotary
  - Vane
  - Screw
  - Lobe

- Dynamic
  - Centrifugal
  - Axial

- Positive displacement compressor operating principles
  - Safety requirements
  - Compression ratios
  - Energy requirements
  - Use in industry

- Non-positive displacement compressor operating principles
  - Safety requirements
  - Air flow
  - Air movement
  - Use in industry
Line (GAC): O SERVICE COMPRESSORS
Competency: O2 Install, maintain and repair compressors

Objectives
To be competent in this area, the individual must be able to:
• Describe maintenance and troubleshooting of compressors.

LEARNING TASKS
1. Describe maintenance of compressors according to manufacturer's specifications
   • Safety requirements
   • Service manuals
   • Installation and leveling
   • Maintenance checks
     o Vibration
     o Alignment
     o Wear
     o Noise
     o Temperature
     o Fluid levels
     o Filters
     o Safety devices
     o Set points
     o Relief/auto valves
     o Condensate drain valves

2. Describe troubleshooting compressors
   • Safe work practices
   • Service manuals
   • Faults
     o Leakage
     o Excessive noise
     o Excessive vibration
     o Excessive force to turn
     o Loss of pressure
     o Overheated components
     o Internal slippage
     o Wear
     o Compression packing
     o Mechanical seals
     o Volumetric efficiency
     o Intake/discharge valves
## Program Content

**Line (GAC):** P  SERVICE PIPING, TANKS AND CONTAINERS  
**Competency:** P1  Select, install and maintain process tanks and containers

### Objectives

To be competent in this area, the individual must be able to:
- Describe the types and functions of process tanks and storage containers.
- Describe troubleshooting, repair and maintenance of process tanks and containers.
- Describe the standard operating procedures for tanks and process vessels for confined space entry.

### LEARNING TASKS

#### 1. Describe types of process tanks and containers

- Process tanks and containers
  - Bins
  - Blow tank
    - Low pressure
    - High pressure
  - Hydraulic
  - Tanks
    - Liquid
    - Chemical
    - Storage
    - Floatation cell
    - Receivers

#### 2. Describe related components for process tanks and containers

- Chutes
- Feeders
- Baffles
- Skirting
- Trippers
- Cyclones
- Ploughs
- Screens
- Separators
- Pollution control equipment
- Agitators
- Vents
- Pumps
- Level indicators

#### 3. Describe troubleshooting of process tanks and containers

- Problems and symptoms
- Inspect components
  - Filters
  - Strainers
  - Piping
  - Agitators
LEARNING TASKS

4. Describe repair procedures for process tanks and containers

CONTENT

- Vents
- Monitoring systems
- NDT or condition-based monitoring
  - Requirements

- Type of repairs
  - Patching
  - Overlay
  - Re-coating
  - Piping

- Failure or breakdown conditions

- Tools and equipment

- Safety procedures
  - Confined space

- Components
  - Dimension measurements
  - Adjust
  - Lubricate
  - Defective
    - Refurbish
    - Replace

- Type of repairs
  - Patch
  - Overlay
  - Re-coat
  - Piping

5. Describe maintenance procedures for process tanks and containers

- Sensory inspection
  - Condition-based monitoring tools
  - NDT

- Manufacturers’ specifications inspection criteria

- Oil filter and strainer

- Fluid level

- Temperature, pressure, vacuum and flow rate

- Valve operation

- Components
  - Pressure relief valves
  - Holes
  - Clearances

- Liners

- Ventilation system blockages
Program Content
Level 3

Line (GAC): P SERVICE PIPING, TANKS AND CONTAINERS
Competency: P2 Select, install and maintain piping

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, maintain and identify the various types and components of material handling systems.
• Assemble and install piping components.

LEARNING TASKS

1. Describe types of piping systems and their components
   • Process
   • Tubing
     o Instrumentation
     o Cooling water
     o Flush water
   • Sealing fluid
   • High/low pressure
   • Components
     o Cyclones
     o Separators
     o Pollution control equipment
     o Agitators
     o Vents
     o Pumps

2. Describe piping materials
   • ABS
   • HDPE
   • PVC
   • Stainless
   • Composite
   • Carbon steel
   • Copper

3. Describe the maintenance and repair of piping systems
   • Problem and symptom diagnosis
   • Tools and equipment
   • Components
     o Filters
     o Strainers
     o Piping
     o Vent
     o Monitoring system
     • NDT or condition-based monitoring requirements
     • Type of repairs
       o Patch
       o Overlay
LEARNING TASKS

CONTENT

- Re-coat
- Replace
- Failure or breakdown conditions
- Sensory inspection
  - Condition-based monitoring tools
  - NDT
- Manufacturers’ specifications inspection criteria
- Oil filters and strainers
- Fluid levels
- Temperatures, pressures, vacuum and flow rates
- Valve operation
- Component clearances
- Ventilation system blockages

4. Assemble and install piping components

- Threads
- Solder
- Tubing

Achievement Criteria

Performance The learner will be able to thread and solder pipe.

Conditions The learner will be given:

- PPE
- Components
- Tools
- Work bench
- Reference resources

Criteria The learner will be evaluated on:

- Safety
- Cleanliness
- Accuracy
- Correct assembly
Program Content
Level 3

Line (GAC): Q SERVICE HYDRAULIC SYSTEMS
Competency: Q1 Identify hydraulic components

Objectives
To be competent in this area, the individual must be able to:
• Identify and describe hydraulic system components.

LEARNING TASKS

1. Identify and describe hydraulic fluids

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

2. Describe fluid conditioners

CONTENT
• Identify
  o Filters
  o Strainers
  o Filtering materials
• Mesh and micron ratings
• Filter and strainer position effectiveness
• Full flow and proportional filtering methods
• 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
• Tubing
  o Sizes
  o Types
  o Measurement
  o Fittings
  o Compatibility with fluids
  o Applications
  o Installation
LEARNING TASKS

CONTENT

4. Describe reservoirs

- 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

- 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

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

6. Describe hydraulic valves

- Check valves
LEARNING TASKS

CONTENT

- 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
- Servo valves
- Pressure actuated valves
  - Relief
  - Unloading
  - Sequence
  - Pressure reducing
  - Brake
  - Location
  - Operation
- Volume control valves
- Servo valves
- Pressure actuated valves
  - Relief
  - Unloading
  - Sequence
  - Pressure reducing
  - Brake
  - Location
  - Operation

7. Describe hydraulic accessories

- Accumulators
  - Purpose
  - Weighted
  - Spring
  - Gas charged
- Intensifiers
  - Purpose
  - Function
- Switches
  - Purpose
  - Function
  - Styles
- Gauges
  - Purpose
  - Function
  - Styles
- Operating principles
  - Hydrodynamic
  - Hydrostatic
- Types of pumps
  - Gear pumps
    - Internal
    - External
  - Vane pumps
    - Balanced
    - Unbalanced
    - Vane design
    - Cartridge
  - Piston pumps
    - Radial
    - Axial
- Pump ratings
  - Displacement

8. Describe hydraulic pumps
LEARNING TASKS

CONTENT
  o Flow rate
  o Volumetric efficiency
Line (GAC): Q SERVICE HYDRAULIC SYSTEMS
Competency: Q2 Assemble hydraulic circuits

Objectives
To be competent in this area, the individual must be able to:
- Design hydraulic circuitry.
- Assemble basic hydraulic circuitry.
- Calibrate, set and adjust hydraulic circuits

LEARNING TASKS
1. Describe and design basic hydraulic circuits
   - Basic linear
   - Basic rotary
   - Regeneration
   - Sequence
   - Reduced pressure
   - Pressure activated
   - Speed control

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

Achievement Criteria
Performance The learner will be able to assemble hydraulic circuits.
Conditions The learner will be given:
- PPE
- Components
- Tools
- Hydraulic simulator
- Reference resources

Criteria The learner will be evaluated on:
- Safety
- Cleanliness
- Accuracy
- Correct assembly
- Circuit function
Line (GAC): Q SERVICE HYDRAULIC SYSTEMS
Competency: Q3 Maintain and repair hydraulic systems

Objectives
To be competent in this area, the individual must be able to:
• Maintain and service hydraulic systems and circuits.
• Troubleshoot faults associated with hydraulic circuits.

LEARNING TASKS

1. Identify hydraulic systems
   • Basic linear
   • Basic rotary
   • Regeneration
   • Sequence
   • Pressure activated
   • Speed control
   • Reduced pressure

2. Maintain hydraulic systems
   • Safety requirements
   • Tools required
   • Testing equipment
   • Troubleshoot
   • Adjustment and calibration
   • Schematic interpretation
   • Identify system failure causes
Program Content
Level 3

Line (GAC): R SERVICE PNEUMATIC AND VACUUM SYSTEMS
Competency: R1 Identify pneumatic and vacuum components

Objectives
To be competent in this area, the individual must be able to:
• Identify and describe pneumatic and vacuum components.

LEARNING TASKS
1. Describe pneumatic conductors

   CONTENT
   • Piping
     o Terminology
       - Pipe diameter
       - Rate of flow
       - Turbulence
       - Friction
       - Wall thickness
       - Bursting pressure
       - Safety factors
     o Types
     o Thread and seal types
   • Tube
     o Types
       - Carbon steel
       - Stainless steel
       - Copper
       - Aluminum
       - Plastic
     o Installation
     o Measuring
     o Bending ratio
     o Fittings
   • Hose
     o Parts
     o Types
     o Pressure rating
     o Fittings
     o Installation

2. Describe pneumatic valves

   CONTENT
   • Valve functions
     o Starting flow
     o Stopping flow
     o Preventing back flow
     o Regulating pressure
     o Relieving pressure
     o Timing
   • Valve types
     o Gate
     o Glove
     o Check
LEARNING TASKS

3. Describe pneumatic filters/separators
   - Function
   - Differences from strainers
   - Types specifications
   - Ratings
   - Locations
   - Air/oil separators

4. Describe pneumatic lubricators
   - Types and specifications
   - Operation
   - Construction

5. Describe pneumatic actuators
   - Linear actuators
     - Parts
     - Classification
     - Construction
     - Seals
     - Variations
     - Sizing
     - Mounting procedures
   - Rotary actuators
     - Parts
     - Construction
     - Seals
     - Variations

6. Describe pneumatic dryers
   - Terminology
     - Relative humidity
     - Absolute humidity
     - Dew point
     - Use of refrigerant for drying
   - Types of driers
     - Desiccant
     - Refrigeration

7. Identify pneumatic compressors
   - Identification
     - Positive
     - Non-positive
LEARNING TASKS

8. Identify components associated with vacuum systems

CONTENT

- Operation
  - Single acting
  - Double acting
  - Single stage
  - Multi stage

- Conductors
  - Tube
  - Hose
  - Pipe
  - Ducting

- Valves
  - Pressure actuated
  - Directional control
  - Load control
  - Pressure regulation
  - Shut-off

- Pumps
  - Positive
  - Non-positive
Line (GAC): R SERVICE PNEUMATIC AND VACUUM SYSTEMS
Competency: R2 Assemble pneumatic and vacuum circuits

Objectives
To be competent in this area, the individual must be able to:
- Interpret and design pneumatic circuitry.
- Assemble basic pneumatic circuitry.
- 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. Identify and describe the types of vacuum circuits found in industry
   - Types of vacuum circuit
     - Production
     - Manufacturing
     - Packaging

Achievement Criteria
Performance The learner will be able to assemble pneumatics circuits.
Conditions The learner will be given:
- PPE
- Components
- Tools
- Pneumatic simulator
- Reference resources
Criteria The learner will be evaluated on:
- Safety
- Cleanliness
- Accuracy
- Correct assembly
- Circuit function
Objectives
To be competent in this area, the individual must be able to:

- Maintain and service pneumatic and vacuum systems.
- Troubleshoot faults associated with pneumatic and vacuum systems.
- Describe the maintenance of dryers.

LEARNING TASKS

1. Identify pneumatic systems
   - Basic linear
   - Basic rotary
   - Sequence
   - Pressure activated
   - Speed control
   - Reduced pressure

2. Maintain pneumatic systems
   - Safety requirements
   - Tools required
   - Testing equipment
   - Troubleshoot
   - Adjustment and calibration
   - Schematic interpretation
   - System failure causes

3. Describe the maintenance of dryers
   - Terminology
     - Relative humidity
     - Absolute humidity
     - Dew point
     - Effects of temperature on humidity
     - Refrigerant for drying
   - Types of dryers
     - Desiccant
     - Refrigeration
     - Deliquescent

4. Maintain vacuum systems and diagnose problems
   - Safety requirements
   - Schematic drawings
   - Fault identification
   - Service manuals
   - Maintenance requirements
   - Adjust and regulate systems
Level 4

Industrial Mechanic (Millwright)
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C1 Use mathematics and science

Objectives
To be competent in this area, the individual must be able to:
- Describe and perform electrical theory calculations.
- Perform calculations relating to prime movers.

LEARNING TASKS
1. Explain the basic theory and perform electrical calculations

   - Theory of electrical principles
     - Atomic theory
     - Voltage
     - Current
     - Resistance
   - Principles of electric circuits
     - Ohm’s Law
     - Power
     - Inductors
     - Inductance
     - Voltage drops
     - Impedance
   - Electrical circuits
     - Series
     - Parallel
     - Complex

2. Perform prime mover calculations

   - Speed
   - Torque
   - Horsepower
   - Ratios
   - Efficiency
   - Energy conversion
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C2 Plan work

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

2. Schedule work

3. Identify and estimate materials and tools and equipment requirements

CONTENT
• Task analysis
• Work estimate
• Time estimate
• Work activity plan
  o Safe work plan
  o Rigging plan
• Coordinate with other trades
• Effective communication
  o Verbal
  o Written
• Interpersonal skills
• Material calculation
  o Request forms
• Tools and equipment
• Delivery coordination
• Documentation
Program Content
Level 4

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C4 Perform leveling of components and systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the leveling and alignment of components.

LEARNING TASKS
1. Describe the leveling and alignment of components

CONTENT
• Prime movers
• Robotics
• Conveying systems
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C9 Use mechanical drawings and specifications

Objectives
To be competent in this area, the individual must be able to:
• Identify and use schematic and graphical symbols used in electrical circuitry as it pertains to NEMA and ISO standards.

LEARNING TASKS
CONTENT
1. Identify and use an electrical schematic symbols
   • Standard graphic symbols
     o ANSI (American National Standards Association)
     o ISO (International Standards Organization)
     o NEMA (National Electrical Manufacturer’s Assoc.)

2. Describe the use of drawings for the installation of machines
   • Prime movers
   • Conveying systems
   • Robotics
Program Content
Level 4

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

- Use trade terminology in clear oral and written communication.
- Identify and interpret paper-based and electronic record keeping systems.
- Read and interpret technical reports.
- Organize and participate in group and multi-trade situations and meetings.

LEARNING TASKS

1. Write and interpret technical reports
   - Information and data
   - Service bulletins
   - Service reports
   - Mechanical drawings to reflect as-built (red line)

2. Use oral communication skills required on the job
   - Communication skills
     - Clarity
     - Concise
     - Body language
     - Listening techniques
   - Terminology
   - Safety issues
   - Discussion participation
   - Mentor apprentices

3. Describe meeting requirements
   - Plan and organize
   - Preparation
   - Conduct a meeting
   - Minute taking
   - Participation and discussion
   - Follow-up

4. Identify and interpret types of software used in the workplace
   - E-mail
   - Web browser
   - CMM systems
Line (GAC):  D  USE COMMUNICATION AND MENTORING TECHNIQUES
Competency:  D2  Use mentoring techniques

Objectives
To be competent in this area, the individual must be able to:
• Mentor and guide the training of apprentices to defined industry standards.

LEARNING TASKS
1. Describe methods for mentoring and guiding the learning of apprentices to defined standards.

2. Use effective communication techniques.

CONTENT
• Learning styles
• Instruction methods
• Confirm student comprehension
• Break down a large body of knowledge into smaller learning tasks
• Communication skills
  o Clarity
  o Concise
  o Body language
  o Listening techniques
• Terminology
• Safety issues
Line (GAC): S SERVICE CONVEYING SYSTEMS
Competency: S1 Identify conveying system components

Objectives
To be competent in this area, the individual must be able to:
- Describe conveying systems, components and their operation.

LEARNING TASKS
1. Describe different types of materials handling
   - Conveyors
   - Bulk handling equipment
   - Blowers
   - Fans
   - 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

3. Identify belt conveyors and components
   - Belt types
     - Standard
     - Reduced ply
     - Solid woven
     - Cord carcass
     - Thin
     - Cable
   - Pulleys
     - Head
     - Drive
     - Snub
     - Return
     - Crown
     - Flat
     - Tail
     - Tracking
LEARNING TASKS

4. Identify bucket elevators and components

5. Identify screw conveyors and components

6. Identify chain conveyors and components

CONTENT

- 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
- Components
  - Belts
  - Case
  - Chain
  - Buckets
  - Pulleys
  - Drives
- Styles of conveyors
  - Centrifugal discharge
  - Positive discharge
  - Continuous discharge
  - Super capacity
- Terminology
  - Pitch
  - Lead
  - Helix angle
  - Flights
- Components
  - Screw
  - Trough
  - Bearings
  - Hangers
  - Drives
  - Accessories
- Components
  - Chain types
  - Sprockets
Program Content
Level 4

LEARNING TASKS

7. Identify pneumatic conveying systems

   • Terminology
     o Low pressure
     o Medium pressure
     o High pressure
     o Vacuum
     o Fluidized

   • System components
     o Blowers
     o Feeders
     o Cyclones
     o Blow pipe

8. 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

9. 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

10. Identify transfer table conveyors and components

    • Types
    • Components
     o Drives
     o Tracks
     o Chain
     o Belt
     o Slack controllers
     o Lifts
     - Hydraulic
LEARNING TASKS

11. Identify monorail systems and their components

12. Describe methods of loading and unloading conveyors

CONTENT

− Pneumatic

● Types

● Components
  ○ Rails
  ○ Chains
  ○ Drives
  ○ Take-up
  ○ Hangers

● Chutes

● Feeders
  ○ Low pressure
  ○ High pressure
  ○ Blow tank feeders
  ○ Hydraulic

● Components
  ○ Baffles
  ○ Skirting
  ○ Trippers
  ○ Cyclones
  ○ Ploughs
  ○ Screens
Line (GAC): S SERVICE CONVEYING SYSTEMS
Competency: S2 Assemble conveying systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the assembly of conveyors.

LEARNING TASKS
1. Describe assembly of conveyors

CONTENT
• Belt
• Bucket elevator
• Screw conveyor
• Chain conveyors
• Pneumatic conveying systems
• Roller conveyors
• Roll case conveyors
• Transfer tables
• Monorail systems
• Water
  o Gravity
  o Mechanical
Line (GAC): S SERVICE CONVEYING SYSTEMS
Competency: S3 Maintain and repair conveying systems

Objectives
To be competent in this area, the individual must be able to:
- Describe maintenance of conveying systems.
- Service conveying systems.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe monitoring systems for conveyors | • Safety  
• Speed  
• Temperature  
• Load  
• Tracking  
• Troubleshooting |
| 2. Describe the maintenance of belt conveyors | • Safety requirements  
• Safety devices  
• Splices  
  - Mechanical  
  - Lacing  
  - Vulcanized  
• Pulleys  
  - Lagging  
• Idlers  
• Repairs  
• Alignment/tracking  
• Drives  
• Procedures  
• Lubrication  
• Tensioning devices  
• Troubleshooting |
| 3. Describe the maintenance of bucket elevators | • Safety requirements  
• Belt  
• Case  
• Chain  
• Buckets  
• Head assembly  
• Drives  
• Tensioning devices  
• Troubleshooting |
<p>| 4. Describe the maintenance of chain conveyors | • Safety requirements |</p>
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 5. Describe the maintenance of pneumatic conveying systems | - Safety requirements  
- Compressors  
- Blowers  
- Feeders  
- Blow pipe  
- Cyclones  
- Bag shakers  
- Precipitators  
- Troubleshooting |
| 6. Describe the maintenance of roller conveyors and roll cases | - Safety requirements  
- Roller wear  
- Alignment  
- Lubrication  
- Drives  
- Troubleshooting |
| 7. Describe the maintenance of transfer table conveyors | - Safety requirements  
- Chain and belt wear  
- Chain and belt tensioning devices  
- Alignment  
- Lubrication  
- Drives  
- Troubleshooting |
| 8. Describe the maintenance of monorail conveyors | - Safety requirements  
- Chain and rail wear  
- Chain tensioning devices  
- Alignment  
- Lubrication  
- Drives  
- Troubleshooting |
| 9. Describe the maintenance of screw conveyors | - Safety requirements  
- Bearings  
- Drives  
- Flights  
- Covers and troughs |
LEARNING TASKS

10. Service conveying systems

CONTENT

• Lubrication
• Troubleshooting
• Belt
• Bucket elevator
• Screw conveyor
• Chain conveyors
• Pneumatic conveying systems
• Roller conveyors
• Roll case conveyors
• Transfer tables
• Monorail systems
• Water
  o Gravity
  o Mechanical

Achievement Criteria

Performance The learner will be able to perform belt splices.

Conditions The learner will be given:
  • PPE
  • Components
  • Tools
  • Reference resources

Criteria The learner will be evaluated on:
  • Safety
  • Cleanliness
  • Accuracy
  • Correct assembly
**Program Content**  
**Level 4**

**Line (GAC):** T SERVICE PRIME MOVERS  
**Competency:** T1 Service electric motors

**Objectives**
To be competent in this area, the individual must be able to:
- Identify the types of AC and DC motors.
- Describe the applications of AC and DC motors.
- Maintain and troubleshoot electric motors.

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| **1. Identify alternating current electric motors** | • Capacitor types  
• Series  
• Induction run  
• Single phase  
• Multi phase  
• Squirrel cage  
• Repulsion start  
• Universal motors |
| **2. Identify direct current electric motors** | • Shunt  
• Series  
• Compound |
| **3. Identify associated components** | • Conductors  
  • Types  
  • Rating  
  • Identification  
  • Protective devices  
    • Fuses  
    • Circuit breakers  
    • Motor starters  
    • Relays  
    • Disconnects |
| **4. Describe the applications of AC and DC motors** | • Power requirements  
• Available power  
• Service entrance capacity  
• Motor speed  
• Duty bearing considerations  
• Motor enclosures  
• Mounting bases  
• Overload protection devices |
| **5. Identify and use tools and equipment for troubleshooting** | • Volt meter  
• Ammeter  
• Ohmmeter |
LEARNING TASKS

6. Maintain and troubleshoot electric motors

CONTENT
- Multimeter
- Megger
- Safety requirements
- Malfunction diagnosis
  - Ground faults
  - Short circuits
  - Overloads
  - Connection
  - Disconnection
  - Overload protection devices
- Maintenance
  - AC motors
  - DC motors
## Program Content

**Line (GAC):** T SERVICE PRIME MOVERS  
**Competency:** T2 Service 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.
- Describe the maintenance and troubleshooting of internal combustion engines.
- Use tools and equipment for maintenance of internal combustion engines.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 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 compression and spark ignition motor components | • Fuel system  
  • Ignition system  
  • Cooling system  
  • Motor components  
    - Valves  
    - Pistons  
    - Cylinders  
    - Crank shafts  
    - Motor blocks  
    - Air intake mechanisms  
    - Exhaust mechanisms  
    - Filters (air and fuel) |
| 3. Identify and use tools and equipment | • Tachometers  
  • Timing lights  
  • Compression testers  
  • Electric load testers  
  • Electronic test equipment |
| 4. Describe maintenance and troubleshooting of internal combustion engines | • Safety requirements  
  • Procedures  
    - Fuel system  
    - Ignition system  
    - Compression  
    - Exhaust  
    - Cooling system |
Line (GAC): T SERVICE PRIME MOVERS
Competency: T3 Service turbines

Objectives
To be competent in this area, the individual must be able to:
• Describe the operating principles of turbines.
• Identify components of turbines.
• Describe the maintenance and troubleshooting of turbines.
• Use tools and equipment for maintenance of turbines.

LEARNING TASKS
1. Describe the operating principles of turbines

   CONTENT
   • Turbine theory
     o Impulse
     o Reaction
     o Combination
   • Types
     o Gas
     o Hydro
     o Steam
     o Wind

2. Identify and describe turbine components

   CONTENT
   • Steam
     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
     o Compressors
     o Combustors
     o Turbine/rotor
     o Fuel
   • Hydro
     o Runners
     o Control mechanisms
     o Pen stocks
   • Wind
     o Tower
     o Nacelle
     o Generator
     o Gearbox
     o Blades
### Program Content
#### Level 4

**LEARNING TASKS**

3. Identify and use tools and equipment for turbines

4. Describe maintenance and troubleshooting of turbines

**CONTENT**

- Vibration meters
- Tachometers
- Boroscopes
- Non-destructive testing equipment
- Safety requirements

**Operation**

- Start-up
- Safety mechanisms
- Governors
- Shutdown

**Procedures**

- Fuel system
- Ignition system
- Inspection
- Routine maintenance
- Lubrication
- Cooling system
- Speed checks
- Vibration
- Safety
- Lock out
- Seal maintenance
Program Content
Level 4

Line (GAC): U PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE

Competency: U1 Perform preventative and predictive maintenance activities

Objectives
To be competent in this area, the individual must be able to:
- Describe the processes used to interpret and record equipment history.
- Describe problem solving flow charts to plan equipment maintenance procedures.
- Describe the types and theory of maintenance scheduling.
- Describe troubleshooting equipment.

LEARNING TASKS
1. Describe equipment maintenance history records
   - Computerized maintenance record keeping systems
   - System and equipment problems

2. Describe procedures used to analyze equipment data
   - Maintenance requirements
   - Maintenance schedules

3. Describe problem solving flow charts
   - Flow charts
     - Safety audit of equipment
     - Production and operation schedules
     - Spare parts inventory
     - Record information for future use
     - Labour requirements
     - Time scheduling
   - Maintenance schedules
     - Comprehend maintenance planning programs
       - Critical path method (CPM)
       - Program evaluation review techniques (PERT)

4. Describe theory of maintenance procedures
   - Maintenance inspections
     - Purpose
       - Prevention
       - Predictive maintenance
     - Inspection procedures
       - Who / what / when
       - Record maintenance
     - Safety requirements
   - Priority maintenance scheduling
     - Maintenance pyramid
       - Critical
       - Important
       - Non-threatening
       - Recoverable failures

5. Describe types of maintenance
   - Maintenance procedures
LEARNING TASKS

6. Describe fluid analysis methods

7. Describe the steps to troubleshoot for equipment deficiencies

CONTENT

- Breakdown maintenance
- Predictive maintenance (PDM)
  - computerization of records keeping (CMMS)
- Preventative maintenance (PM)

  - Ferrography
  - Spectrography
  - Viscosity
  - Particle count
  - Filter patch

- Machine knowledge
- Schematic
- Service manuals
- Operator
- Possible causes
- Conclusion
  - Test
Program Content
Level 4

Line (GAC): U PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE

Competency: U2 Perform vibration analysis procedures

Objectives
To be competent in this area, the individual must be able to:
• Describe vibrational analysis theory and procedures.
• Analyze vibration test data.

LEARNING TASKS

1. Describe vibration analysis theory
   • Application
   • Advantages and disadvantages
   • Terminology
     o Amplitude
     o Frequency
     o Natural frequency
     o Resonance
     o Critical speed
     o Harmonic
   • Equipment
     o Light beam vibration indicator
     o Battery operated meter

2. Describe vibration analysis procedures
   • Safety
   • Theory and characteristics
   • Types of analyzers and applications
   • Manufacturers’ specifications
   • Noise measurement
   • Vibration frequencies
     o Journal and rolling element bearings
     o Mechanical looseness
     o Rubbing
     o Excessive lubrication
     o Gears
     o Belts
     o Cavitation
   • Equipment selection
   • Transducer installation
   • Causes
     o Imbalance
     o Corrosion
     o Wear
     o Eccentricity
     o Shaft problems
     o Misalignment
     o Distortion
LEARNING TASKS
3. Analyze vibration test data

CONTENT
- Test equipment
- Data recording systems
- Scheduling procedures
- Vibration limits and tolerances
  - Manufacturers' specifications
- Equipment data download procedures
- Alarm thresholds
Line (GAC): U PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE

Competency: U3 Perform balancing procedures

Objectives
To be competent in this area, the individual must be able to:
• Describe equipment balancing.

LEARNING TASKS
1. Describe equipment balancing

CONTENT
• Safe work practices
• Balance testing
  o Application
  o Equipment
• Pre-balance procedures and requirements
• Balancing methods
  o Static/dynamic
  o Single and multi-plane
• Formula calculations
• Imbalance recognition
• ISO standards
Line (GAC): U PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE

Competency: U4 Perform non-destructive evaluation (NDE) procedures

Objectives
To be competent in this area, the individual must be able to:
• Describe the methods of non-destructive evaluation.

LEARNING TASKS
1. Describe the methods of non-destructive evaluation

CONTENT
• Dye penetration
  o Types
  o Limitations
• Ultrasonic testing
  o Applications
  o Advantages and disadvantages
  o Certification required
• Radiography testing
  o Applications
  o Advantages and disadvantages
  o Safety requirements
  o Types of equipment
  o Certification required
• Mechanical particle testing
  o Application
  o Advantages and disadvantages
  o Methods of use
  o Limitations
  o Type of defects located
  o Equipment required
• Infrared testing
  o Application
  o Equipment
  o Advantages and disadvantages
  o Limitations
• Visual testing
  o Application
  o Equipment
  o Advantages and disadvantages
• Temperature monitoring equipment
  o Temperature probes
  o Thermographic equipment
Line (GAC): V PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT

Competency: V1 Commission systems and components

Objectives
To be competent in this area, the individual must be able to:
- Explain the reference data required for the commissioning procedure.
- Describe and perform commissioning procedures.

LEARNING TASKS
1. Identify reference data and jurisdictional regulations for commissioning equipment
   - Blueprints
   - Service manuals
   - Start-up procedures
   - Commissioning report
   - Environmental
   - Safety

2. Describe and perform commissioning procedures
   - Equipment and systems
     - Fuel
     - Lube oil
     - Freedom of movement
     - Electrical
     - Test equipment
     - Air
     - Cooling
   - Test and trials
     - Schedules
     - Specific performance standards
     - Comparison to specifications
     - Safety/guards/emergency stops
     - Maintenance arrangements
     - Noise level
     - Defects
   - Identify and document required changes
     - Sumps
     - Drainage
     - Vibration
     - Pipe hangers
     - Insulation
     - Couplings
   - Report
     - Warranty
     - Defects
   - Test results examination
     - Defects
     - Deficiencies
LEARNING TASKS

<table>
<thead>
<tr>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Categorize</td>
</tr>
<tr>
<td>o Warranty</td>
</tr>
<tr>
<td>o Design</td>
</tr>
<tr>
<td>• Commissioning improvement recommendations</td>
</tr>
</tbody>
</table>

### Achievement Criteria

<table>
<thead>
<tr>
<th>Performance</th>
<th>The learner will be able to use provided resources for a simulated commissioning of equipment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions</td>
<td>The learner will be given:</td>
</tr>
<tr>
<td></td>
<td>• Scenario</td>
</tr>
<tr>
<td></td>
<td>• Reports, records and data</td>
</tr>
<tr>
<td></td>
<td>• Reference resources</td>
</tr>
<tr>
<td>Criteria</td>
<td>The learner will be evaluated on:</td>
</tr>
<tr>
<td></td>
<td>• Safety</td>
</tr>
<tr>
<td></td>
<td>• Accuracy</td>
</tr>
</tbody>
</table>
Line (GAC): V PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT

Competency: V2 Decommission systems and components

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

- Explain the reference data required for the decommissioning procedure.
- Describe decommissioning procedures.

LEARNING TASKS
1. Identify reference data and jurisdictional regulations for decommissioning equipment

   - Blueprints
   - Service manuals
   - Shut-down procedures
   - Decommissioning report
   - Environmental
     - Remediation
     - Disposal
     - Recycle
     - Reduce
   - Safety considerations

2. Describe decommissioning procedures

   - Equipment and systems
     - Fuel
     - Lube oil
     - Freedom of movement
     - Electrical
     - Test equipment
     - Air
     - Cooling
     - Piping
   - Shut-down or removal
     - Safety/guards
     - Zero energy
     - Maintenance arrangements
     - Storage/preservation
   - Identification and documentation of required changes
     - Sumps
     - Drainage
     - Vibration
     - Pipe hangers
     - Insulation
     - Couplings
   - Reports/permits
Line (GAC): W SERVICE MECHANICAL COMPONENTS OF ROBOTICS AND AUTOMATED EQUIPMENT

Competency: W1 Service robotics and automated equipment

Objectives
To be competent in this area, the individual must be able to:
• Define terminology of robotics and automated equipment.
• Describe the installation, maintenance and troubleshooting of robotics and automated equipment.

LEARNING TASKS

1. Describe robotics and automated equipment
   - Safety
     - Hazards
   - Terminology
     - Controllers
     - Components
     - Safety devices
   - Classifications
   - Range of motion

2. Describe the installation of robotics and automated equipment
   - Tools
   - Site & manufacturers’ specifications
   - Engineered drawings
   - Jurisdictional regulations
   - Safety guards and devices
   - Controller connections

3. Describe routine maintenance of robotics and automated equipment
   - Tools
   - Coolant
   - Lubricant
   - Packing and seals
   - Safety devices
   - Temperature
   - Vibration
   - Flow
   - Pressure
   - Range of motion
   - Adjustment and calibration

4. Describe troubleshooting of robotics and automated equipment
   - Tools
   - Diagnosis procedures
   - System failure causes
   - Repair
   - Replace
   - Testing equipment
   - Schematic interpretation
Section 4

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
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
- Scrapers
- 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 threader
- 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 (dumpy)
- 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
- Scribers
- 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
- Tirfors
- 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 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
- 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
Information Materials

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

Catalogues
- Hazardous material signs
- SDS
- Service manuals
- WHMIS 2015
- IPT handbooks (strongly recommended)
  - Rotating equipment
  - Safety
  - Rigging
  - Hydraulics
  - Industrial fasteners and fittings
  - Power transmissions
Reference Materials

Required Reference Materials

- BC Millwright Manual
- Millwright Modules from Alberta Learning as identified by Articulation Committee
- WCB Health & Safety Regulations (online)

Recommended Resources

- Math for Technical and Vocational Students by John G. Boyce
- Basic Blueprint Reading & Sketching by Thomas P. Alivio and C. Thomas Olivo
- Industrial Hydraulics by Parker Hannifin Corporation
- Industrial Hydraulics Manual by Eaton
- Basic Pneumatic Technology by Parker Hannifin Corporation
- Machine Shop Basics by Audel
- Machinery Handbook by Industrial Press
- Interpreting Engineering Drawings by Cecil H. Jensen
- Technology of Machine Tools by Steve Krar, Arthur Gill and Peter Smid
- SKF Bearing Maintenance Handbook by the SKF Bearing Corporation
- Fundamentals of Applied Physics by C. Thomas Olivo and Thomas P. Alivio
- IPT Manuals – Rotating Equipment and Power Transmissions by IPT Publishing and Training Ltd.
- Pump Handbook by Igor Karassik, Joseph Messina and Paul Cooper
Instructor Requirements

**Occupation Qualification**

The instructor must possess:

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

**Work Experience**

- A minimum of 5 years’ hands-on experience working as a Industrial Mechanic (Millwright) after earning Interprovincial Red Seal certification

**Instructional Experience and Education**

It is preferred that the instructor also possesses the following:

- Provincial (BC) Instructor Diploma or completion of a similar Trainer Training / Instructional Methods program, plus
- 2 years’ of instructional experience
APPENDIX A

Assessment Guidelines
# Level 1 Grading Sheet: Subject Competency and Weightings

## PROGRAM:
**IN-SCHOOL TRAINING:**
**INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 1**

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>PERFORM SAFETY RELATED FUNCTIONS</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>USE TOOLS AND EQUIPMENT</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>C</td>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>D</td>
<td>USE COMMUNICATION AND MENTORING TECHNIQUES</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>E</td>
<td>PERFORM MEASURING AND LAYOUT OF WORK PIECE</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>F</td>
<td>PERFORM CUTTING AND WELDING OPERATIONS</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>G</td>
<td>PERFORM RIGGING, HOISTING/LIFTING AND MOVING</td>
<td>20%</td>
<td>25%</td>
</tr>
</tbody>
</table>

**Total** 100% 100%

**In-school theory / practical subject competency weighting**

<table>
<thead>
<tr>
<th>In-school Percentage Score</th>
<th>IN-SCHOOL %</th>
</tr>
</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%
## Level 2 Grading Sheet: Subject Competency and Weightings

**PROGRAM: IN-SCHOOL TRAINING:**

**INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 2**

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>F</td>
<td>PERFORM CUTTING AND WELDING OPERATIONS</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>H</td>
<td>SERVICE SHAFTS, BEARINGS AND SEALS</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>I</td>
<td>SERVICE COUPLINGS, CLUTCHES AND BRAKES</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>J</td>
<td>SERVICE CHAIN AND BELT DRIVE SYSTEMS</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>K</td>
<td>SERVICE GEAR SYSTEMS</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>L</td>
<td>PERFORM SHAFT ALIGNMENT PROCEDURES</td>
<td>15%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Total** 100% 100%

**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%
## Level 3 Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>PROGRAM: IN-SCHOOL TRAINING:</th>
<th>INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINE</td>
<td>SUBJECT COMPETENCIES</td>
</tr>
<tr>
<td>C</td>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
</tr>
<tr>
<td>L</td>
<td>PERFORM SHAFT ALIGNMENT PROCEDURES</td>
</tr>
<tr>
<td>M</td>
<td>SERVICE FANS AND BLOWERS</td>
</tr>
<tr>
<td>N</td>
<td>SERVICE PUMPS</td>
</tr>
<tr>
<td>O</td>
<td>SERVICE COMPRESSORS</td>
</tr>
<tr>
<td>P</td>
<td>SERVICE PIPING, TANKS AND CONTAINERS</td>
</tr>
<tr>
<td>Q</td>
<td>SERVICE HYDRAULIC SYSTEMS</td>
</tr>
<tr>
<td>R</td>
<td>SERVICE PNEUMATIC AND VACUUM SYSTEMS</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

**In-school theory / practical subject competency weighting**

- 75%
- 25%

**Final in-school percentage score**

- IN-SCHOOL %

<table>
<thead>
<tr>
<th>In-school Percentage Score</th>
<th>Combined theory and practical subject competency multiplied by 80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Level Exam Percentage Score</td>
<td>The exam score is multiplied by 20%</td>
</tr>
</tbody>
</table>

**Final Percentage Score**

- FINAL%
# Level 4 Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>D</td>
<td>USE COMMUNICATION AND MENTORING TECHNIQUES</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>S</td>
<td>SERVICE CONVEYING SYSTEMS</td>
<td>21%</td>
<td>50%</td>
</tr>
<tr>
<td>T</td>
<td>SERVICE PRIME MOVERS</td>
<td>28%</td>
<td>0%</td>
</tr>
<tr>
<td>U</td>
<td>PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE</td>
<td>21%</td>
<td>0%</td>
</tr>
<tr>
<td>V</td>
<td>PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT</td>
<td>10%</td>
<td>50%</td>
</tr>
<tr>
<td>W</td>
<td>SERVICE ROBOTICS AND AUTOMATED EQUIPMENT</td>
<td>5%</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**

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 B

Glossary of Terms and Acronyms
## Appendix B: Glossary of Terms and Acronyms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Acrylonitrile butadiene styrene (type of plastic)</td>
</tr>
<tr>
<td>Adjust</td>
<td>To bring to a more satisfactory state. To bring the parts of to a true or more effective relative position.</td>
</tr>
<tr>
<td>Align</td>
<td>To bring into alignment.</td>
</tr>
<tr>
<td>Analyze</td>
<td>To examine critically so as to determine appropriate procedures, process, or course of action.</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Association</td>
</tr>
<tr>
<td>Apply</td>
<td>To put to use especially for some practical purpose.</td>
</tr>
<tr>
<td>Assemble</td>
<td>To fit together the parts of.</td>
</tr>
<tr>
<td>Assess</td>
<td>To determine the value, significance, or extent of; appraise.</td>
</tr>
<tr>
<td>Calculate</td>
<td>To arrive at a precise numerical answer – often through the use of mathematical formulas.</td>
</tr>
<tr>
<td>CMMS</td>
<td>Computerized maintenance management system</td>
</tr>
<tr>
<td>Construct</td>
<td>To make or form by combining or arranging parts or elements.</td>
</tr>
<tr>
<td>CPM</td>
<td>Critical Path Method</td>
</tr>
<tr>
<td>Define</td>
<td>To set forth the meaning of a word or expression.</td>
</tr>
<tr>
<td>Demonstrate</td>
<td>To exhibit, show clearly or perform, to a competency standard, a process or competence.</td>
</tr>
<tr>
<td>Describe</td>
<td>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.)</td>
</tr>
<tr>
<td>Determine</td>
<td>To arrive at, or locate, information by a simple process (e.g. by rule of thumb).</td>
</tr>
<tr>
<td>Explain</td>
<td>To show the logical development or relationships of.</td>
</tr>
<tr>
<td>Evaluate</td>
<td>To determine the significance, worth, or condition of usually by careful appraisal and study.</td>
</tr>
<tr>
<td>HDPE</td>
<td>High-density polyethylene</td>
</tr>
<tr>
<td>Identify</td>
<td>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.</td>
</tr>
<tr>
<td>Inspect</td>
<td>To look into, or at carefully. To examine, or observe, critically in order to detect flaws, errors, etc.</td>
</tr>
<tr>
<td>Install</td>
<td>To set up for use or service.</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Association</td>
</tr>
<tr>
<td>JIC</td>
<td>Joint Industry Conference</td>
</tr>
<tr>
<td>Jurisdictional regulations:</td>
<td>Includes ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS 2015), Canadian Nuclear Safety Commission), provincial/territorial (worker’s rights and responsibilities), and municipal</td>
</tr>
</tbody>
</table>
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.
NEMA: National Electrical Manufacturer’s Association
NDT: Non-destructive testing
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.
PERT: Program Evaluation Review Techniques
PDM: Predictive maintenance
PM: Preventative maintenance
PVC: Polyvinyl chloride (type of plastic)
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.
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 C

Previous Contributors
Appendices

Appendix C: Previous Contributors

Millwright Standards Project SMEs (2014)

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

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 Albernia Pulp & Paper
- Bruce McKague: Highland Valley Copper (Teck)
- Doug Wiebe: Kwantlen Polytechnic University