SKILLEDTRADES BC

PROGRAM OUTLINE

Industrial Mechanic (Millwright)

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INDUSTRIAL MECHANIC (MILLWRIGHT)
PROGRAM OUTLINE

APPROVED BY INDUSTRY

MARCH 2017

BASED ON

RSOS 2016

Developed by
SkilledTradesBC
Province of British Columbia

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Section 1

INTRODUCTION

Industrial Mechanic (Millwright)

Foreword

The Program Standards for Industrial Mechanic (Millwright) 2017 were updated through a Standards Review project funded by SkilledTradesBC.

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

SkilledTradesBC 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.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	Understand challenger pathway to Certificate of Qualification
OAC	Communicate the competencies that industry has defined as representing the scope of the occupation	Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification	View the competencies they will achieve as a result of program completion	Understand the competencies they must demonstrate in order to challenge the program
Training Topics and Suggested Time Allocation	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	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	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	Understand the relative weightings of various competencies of the occupation on which assessment is based
Program Content	Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measureable achievement criteria for objectives with a practical component	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	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	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	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	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

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Appendix – Glossary of Acronyms			Defines program specific acronyms	

Section 2

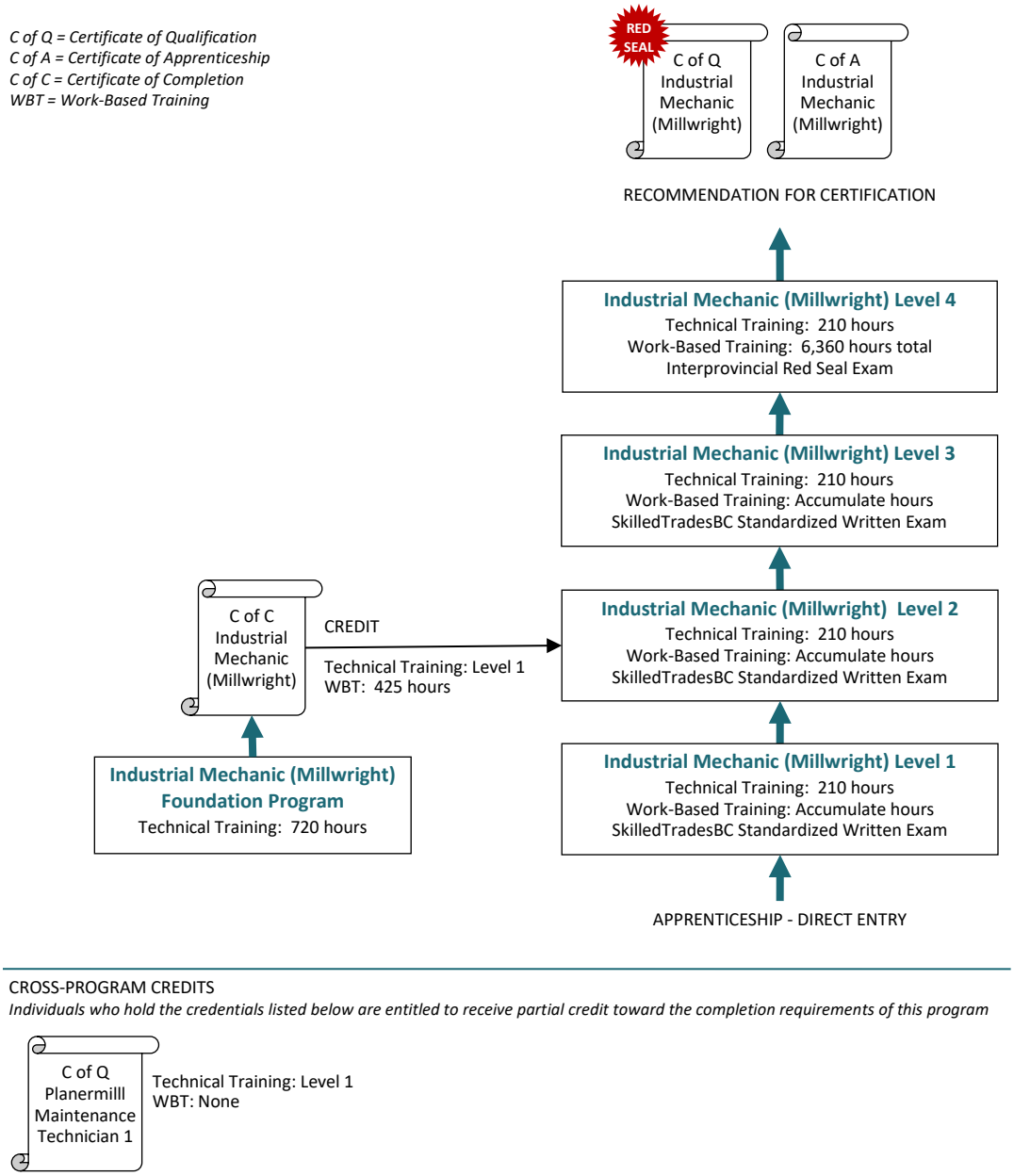
PROGRAM OVERVIEW

Industrial Mechanic (Millwright)

Program Credentialing Model

Apprenticeship Pathway

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



CROSS-PROGRAM CREDITS

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

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.

Line	Task	Code					
PERFORM SAFETY RELATED FUNCTIONS (A)	Use codes, regulations and standards	A1	1				
	Use personal protective equipment (PPE) and safety equipment	A2	1				
	Maintain safe worksite	A3	1				
	Perform lock-out, tag-out and zero energy procedures	A4	1				
USE TOOLS AND EQUIPMENT (B)	Use hand and portable power tools	B1	1				
	Use shop machines	B2	1				
	Use access equipment	B3	1				
PERFORM ROUTINE TRADE ACTIVITIES (C)	Use mathematics and science	C1	1	2	3	4	
	Plan work	C2				4	
	Lubricate systems and components	C3	1	2			
	Perform leveling of components and systems	C4	1	2	3	4	
	Use fastening and retaining devices	C5	1				
	Use manufacturer, supplier and reference documentation	C6	1				
	Perform material identification	C7		2			
	Perform heat treatment of metal	C8		2			
	Use mechanical drawings and specifications	C9	1	2	3	4	

USE COMMUNICATION AND MENTORING TECHNIQUES **D**	Use communication techniques D1				
	1			4	
	Use mentoring techniques D2				
				4	
PERFORM MEASURING AND LAYOUT OF WORK PIECE **E**	Prepare work area, tools and equipment E1				
	1				
	Layout and fabricate work piece E2				
	1				
PERFORM CUTTING AND WELDING OPERATIONS **F**	Cut material with oxy-fuel and plasma arc cutting equipment F1				
	1				
	Weld material using shielded arc welding equipment (SMAW) F2				
		2			
	Weld material with gas metal arc welding equipment (GMAW) F3				
		2			
	Weld material with gas tungsten arc welding equipment (GTAW) F4				
		2			
PERFORM RIGGING, HOISTING/LIFTING AND MOVING **G**	Select and use sling and rigging attachments G1				
	1				
	Select and use hoisting and lifting equipment G2				
	1				
	Create a rigging plan G3				
	1				
SERVICE SHAFTS, BEARINGS AND SEALS **H**	Select, install and maintain shafts H1				
		2			
	Select, install and maintain bearings H2				
		2			
	Select, install and maintain seals H3				
		2			
SERVICE COUPLINGS, CLUTCHES AND BRAKES **I**	Select, install and maintain couplings I1				
		2			
	Select, install and maintain clutches and brakes I2				
		2			

SERVICE CHAIN AND BELT DRIVE SYSTEMS **J**	Select, install and maintain chain drive systems J1		2				Select, install and maintain belt drive systems J2		2		
SERVICE GEAR SYSTEMS **K**	Select and install gear systems K1		2				Diagnose, maintain and repair gear systems K2		2		
PERFORM SHAFT ALIGNMENT PROCEDURES **L**	Perform rough alignment L1		2				Perform dial alignment procedures L2		2	3	
	Perform laser alignment L3			3							
SERVICE FANS AND BLOWERS **M**	Select, install and maintain fans M1			3			Select, install and maintain blowers M2			3	
SERVICE PUMPS **N**	Identify and select positive displacement pumps N1			3			Install, maintain and repair positive displacement pumps N2			3	
	Identify and select non-positive displacement pumps N3			3			Install, maintain and repair non-positive displacement pumps N4			3	
SERVICE COMPRESSORS **O**	Identify and select compressors O1			3			Install, maintain and repair compressors O2			3	

SERVICE PIPING, TANKS AND CONTAINERS **P**	Select, install and maintain process tanks and containers P1		3	
	Select, install and maintain piping P2		3	
SERVICE HYDRAULIC SYSTEMS **Q**	Identify hydraulic components Q1		3	
	Assemble hydraulic circuits Q2		3	
	Maintain and repair hydraulic systems Q3		3	
SERVICE PNEUMATIC AND VACUUM SYSTEMS **R**	Identify pneumatic and vacuum components R1		3	
	Assemble pneumatic and vacuum circuits R2		3	
	Maintain and repair pneumatic and vacuum systems R3		3	
SERVICE CONVEYING SYSTEMS **S**	Identify conveying system components S1		4	
	Assemble conveying systems S2		4	
	Maintain and repair conveying systems S3		4	
SERVICE PRIME MOVERS **T**	Service electric motors T1		4	
	Service internal combustion engines T2		4	
	Service turbines T3		4	
PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE **U**	Perform preventative and predictive maintenance activities U1		4	
	Perform vibration analysis procedures U2		4	
	Perform balancing procedures U3		4	
	Perform non-destructive evaluation (NDE) procedures U4		4	

PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT V	Commission systems and components V1						Decommission systems and components V2					
				4						4		

SERVICE ROBOTICS AND AUTOMATED EQUIPMENT W	Service robotics and automated equipment W1				
			4		

Training Topics and Suggested Time Allocation: Level 1

INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 1

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**PERFORM SAFETY RELATED FUNCTIONS**	**17%**	**90%**	**10%**	**100%**
A1	Use codes, regulations and standards		✓		
A2	Use personal protective equipment (PPE) and safety equipment		✓	✓	
A3	Maintain safe worksite		✓	✓	
A4	Perform lock-out, tag-out and zero energy procedures		✓	✓	
Line B	**USE TOOLS AND EQUIPMENT**	**22%**	**70%**	**30%**	**100%**
B1	Use hand and portable power tools		✓	✓	
B2	Use shop machines		✓	✓	
B3	Use access equipment		✓	✓	
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**30%**	**90%**	**10%**	**100%**
C1	Use mathematics and science		✓		
C3	Lubricate systems and components		✓		
C4	Perform leveling of components and systems		✓		
C5	Use fastening and retaining devices		✓	✓	
C6	Use manufacturer, supplier and reference documentation		✓		
C9	Use mechanical drawings and specifications		✓	✓	
Line D	**USE COMMUNICATION AND MENTORING TECHNIQUES**	**2%**	**100%**	**0%**	**100%**
D1	Use communication techniques		✓		
Line E	**PERFORM MEASURING AND LAYOUT OF WORK PIECE**	**6%**	**70%**	**30%**	**100%**
E1	Prepare work area, tools and equipment		✓	✓	
E2	Layout and fabricate work piece		✓	✓	
Line F	**PERFORM CUTTING AND WELDING OPERATIONS**	**13%**	**25%**	**75%**	**100%**
F1	Cut material with oxy-fuel and plasma arc cutting equipment		✓		
Line G	**PERFORM RIGGING, HOISTING/LIFTING AND MOVING**	**10%**	**75%**	**25%**	**100%**
G1	Select and use sling and rigging attachments		✓		
G2	Select and use hoisting and lifting equipment		✓		
G3	Create a rigging plan		✓		
	Total Percentage for Millwright Level 1	**100%**			

Training Topics and Suggested Time Allocation: Level 2

INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 2

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**25%**	**85%**	**15%**	**100%**
C1	Use mathematics and science		✓	✓	
C3	Lubricate systems and components		✓	✓	
C4	Perform leveling of components and systems		✓		
C7	Perform material identification		✓		
C8	Perform heat treatment of metal		✓	✓	
C9	Use mechanical drawings and specifications		✓		
Line F	**PERFORM CUTTING AND WELDING OPERATIONS**	**14%**	**25%**	**75%**	**100%**
F2	Weld material using shielded arc welding equipment (SMAW)		✓	✓	
F3	Weld material with gas metal arc welding equipment (GMAW)		✓	✓	
F4	Weld material with gas tungsten arc welding equipment (GTAW)		✓	✓	
Line H	**SERVICE SHAFTS, BEARINGS AND SEALS**	**19%**	**75%**	**25%**	**100%**
H1	Select, install and maintain shafts		✓	✓	
H2	Select, install and maintain bearings		✓	✓	
H3	Select, install and maintain seals		✓	✓	
Line I	**SERVICE COUPLINGS, CLUTCHES AND BRAKES**	**10%**	**90%**	**10%**	**100%**
I1	Select, install and maintain couplings		✓	✓	
I2	Select, install and maintain clutches and brakes		✓	✓	
Line J	**SERVICE CHAIN AND BELT DRIVE SYSTEMS**	**12%**	**80%**	**20%**	**100%**
J1	Select, install and maintain chain drive systems		✓	✓	
J2	Select, install and maintain belt drive systems		✓	✓	
Line K	**SERVICE GEAR SYSTEMS**	**10%**	**70%**	**30%**	**100%**
K1	Select and install gear systems		✓		
K2	Diagnose, maintain and repair gear systems		✓	✓	
Line L	**PERFORM SHAFT ALIGNMENT PROCEDURES**	**10%**	**50%**	**50%**	**100%**
L1	Perform rough alignment		✓	✓	
L2	Perform dial alignment procedures		✓	✓	
	Total Percentage for Millwright Level 2	**100%**			

Training Topics and Suggested Time Allocation: Level 3

INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 3

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**9%**	**100%**	**0%**	**100%**
C1	Use mathematics and science		✓		
C4	Perform leveling of components and systems		✓		
C9	Use mechanical drawings and specifications		✓		
Line L	**PERFORM SHAFT ALIGNMENT PROCEDURES**	**4%**	**50%**	**50%**	**100%**
L2	Perform dial alignment		✓	✓	
L3	Perform laser alignment		✓	✓	
Line M	**SERVICE FANS AND BLOWERS**	**5%**	**100%**	**0%**	**100%**
M1	Select, install and maintain fans		✓		
M2	Select, install and maintain blowers		✓		
Line N	**SERVICE PUMPS**	**19%**	**80%**	**20%**	**100%**
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		✓	✓	
Line O	**SERVICE COMPRESSORS**	**15%**	**100%**	**0%**	**100%**
O1	Identify and select compressors		✓		
O2	Install, maintain and repair compressors		✓		
Line P	**SERVICE PIPING, TANKS AND CONTAINERS**	**10%**	**90%**	**10%**	**100%**
P1	Select, install and maintain process tanks and containers		✓		
P2	Select, install and maintain piping		✓	✓	
Line Q	**SERVICE HYDRAULIC SYSTEMS**	**29%**	**75%**	**25%**	**100%**
Q1	Identify hydraulic components		✓		
Q2	Assemble hydraulic circuits		✓	✓	
Q3	Maintain and repair hydraulic systems		✓	✓	
Line R	**SERVICE PNEUMATIC AND VACUUM SYSTEMS**	**9%**	**70%**	**30%**	**100%**
R1	Identify pneumatic and vacuum components		✓		
R2	Assemble pneumatic and vacuum circuits		✓	✓	
R3	Maintain and repair pneumatic and vacuum systems		✓	✓	
	Total Percentage for Millwright Level 3	**100%**			

Training Topics and Suggested Time Allocation: Level 4

INDUSTRIAL MECHANIC (MILLWRIGHT) – LEVEL 4

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**18%**	**100%**	**0%**	**100%**
C1	Use mathematics and science		✓		
C2	Plan work		✓		
C4	Perform leveling of components and systems		✓		
C9	Use mechanical drawings and specifications		✓		
Line D	**USE COMMUNICATION AND MENTORING TECHNIQUES**	**3%**	**100%**	**0%**	**100%**
D1	Use communication techniques		✓		
D2	Use mentoring techniques		✓		
Line S	**SERVICE CONVEYING SYSTEMS**	**17%**	**80%**	**20%**	**100%**
S1	Identify conveying systems		✓		
S2	Assemble conveying systems		✓		
S3	Maintain and repair conveying systems		✓		
Line T	**SERVICE PRIME MOVERS**	**30%**	**80%**	**20%**	**100%**
T1	Service electric motors		✓	✓	
T2	Service internal combustion engines		✓	✓	
T3	Service turbines		✓	✓	
Line U	**PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE**	**13%**	**100%**	**0%**	**100%**
U1	Perform preventative and predictive maintenance activities		✓		
U2	Perform vibration analysis procedures		✓		
U3	Perform balancing procedures		✓		
U4	Perform non-destructive evaluation (NDE) procedures		✓		
Line V	**PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT**	**7%**	**90%**	**10%**	**100%**
V1	Commission systems and components		✓	✓	
V2	Decommission systems and components		✓		
Line W	**SERVICE ROBOTICS AND AUTOMATED EQUIPMENT**	**12%**	**100%**	**0%**	**100%**
W1	Service robotics and automated equipment		✓		
	Total Percentage for Millwright Level 4	**100%**			

Section 3

PROGRAM CONTENT

Industrial Mechanic (Millwright)

Level 1

Industrial Mechanic (Millwright)

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	CONTENT
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

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS

Competency: A2 Use personal protective equipment (PPE) and safety equipment

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	CONTENT

1. Identify and select personal safety equipment	• Jurisdictional regulations
	  ○ Job site policy
	  ○ WorkSafe BC
	  ○ BC Safety Authority
	• Respirators
	• Eye protection / face shield
	• Eye-wash stations
	• Hearing protection
	• Hand protection
	• Head protection
	• Foot protection
	• Clothing (safety vest, coveralls)
	• Fall arrest

2. Use personal safety equipment	• Respirators • Eye protection / face shield • Eye-wash stations • Hearing protection • Hand protection • Head protection • Foot protection • Clothing (safety vest, coveralls)
3. Explain the proper maintenance and storage of personal safety equipment	• Respirators • Eye protection / face shield • Eye-wash stations • Hearing protection • Head protection • Clothing (safety vest, coveralls) • Fall arrest

Line (GAC): A 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	CONTENT

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

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

3. State the work purpose of the Workplace Hazardous Materials Information System (WHMIS 2015)	• Worker protection
	  ○ Hazardous materials
	  ○ Relevant information
	• Economic impact
	• Minimize work disruptions

LEARNING TASKS	CONTENT

4. Describe the key elements of WHMIS 2015	• Recognition of rights
	  ○ Workers
	  ○ Employers
	  ○ Suppliers
	  ○ Regulators
	• Safety data sheets (SDS)
	• Hazardous material labelling
	• Worker education programs

5. Describe the responsibilities of suppliers under WHMIS 2015	• Provide
	  ○ SDSs
	  ○ Labels

6. Describe the responsibilities of employers under WHMIS 2015	• Provide
	  ○ SDSs
	  ○ Labels
	  ○ Work education programs in the workplace

7. Describe information to be disclosed on a SDS	• Hazardous ingredients • Preparation information • Product information • Physical data • Fire or explosion • Reactivity data • Toxicological properties • Preventive measures • First-aid measures

8. Identify symbols found on WHMIS 2015 labels and their meaning	• Compressed gases
	• Flammable and combustible materials
	• Oxidizing materials
	• Poisonous and infectious materials
	  ○ Materials causing immediate and serious toxic effects
	  ○ Materials causing other toxic effects
	  ○ Bio-hazardous infectious materials
	  ○ Corrosive materials
	  ○ Dangerously reactive materials

9. Explain how WHMIS 2015 applies to hazardous materials used in the shop	• Use, storage and disposal
	  ○ Solvents
	  ○ Caustic cleaners
	  ○ Cleaning solutions

10. Describe proper use of guards and guarding for various situations	• CSA Standards
	• Styles
	  ○ Interlock
	  ○ Standard
	  ○ Enclosed

LEARNING TASKS	CONTENT
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
	  ○ Signed
	  ○ Dated
	  ○ Sealed
	• Identification
	  ○ Colour
	  ○ Shape
	  ○ 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

LEARNING TASKS	CONTENT

19. Identify the risks of repetitive motion	• Ergonomics
	• Repetitive motion
	  ○ Hand
	  ○ Arm
	  ○ 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	CONTENT

1. Identify energy sources and lock-out requirements	• Zero energy
	  ○ Depressurize
	  ○ Jurisdictional regulations
	• Energy sources

2. Identify lock-out and tag-out procedures	• Lock • Tags • Cable • Lock box • Blocking • Blanking
3. Identify zero energy state	• Gravity • Stored energy

4. Use lock-out and tag-out procedures	• Zero energy state
	  ○ Disconnect
	  ○ Depressurize
	  ○ Isolate
	• Lock-out
	• Test

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	CONTENT

1. Identify hand and portable power tools	• 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

2. Use hand and portable power tools	• 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

3. Inspect, maintain and store hand and portable power tools	• 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	CONTENT
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 ○ 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

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	CONTENT

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

2. Select and use access equipment	• Jurisdictional regulations
	• Fall protection
	• Maintenance
	  ○ Unsafe equipment
	  ○ Pre-use inspection
	• Care and storage

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	CONTENT
1. Use a scientific calculator	• Hierarchy • Functions • Usage

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

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

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

5. Solve problems using ratio and proportion	• Terminology

LEARNING TASKS	CONTENT
6. Solve problems with percentages	○ Ratio ○ Terms ○ Proportion ○ Cross multiplication ○ Inverse ratio ○ Inverse proportion • Ratio calculations • Proportion calculations ○ Proper proportions ○ Inverse proportions • Terminology ○ Common fraction ○ Decimal fraction • Percentage calculations
7. Solve problems dealing with perimeters and circumference	• Concept of perimeters • Geometric shapes ○ Squares ○ Triangles ○ Rectangles ○ Arcs ○ Circles/ellipse
8. Solve problems dealing with areas and volumes	• Concept of area • Geometric shapes ○ Squares ○ Triangles ○ Rectangles ○ Arcs ○ Circles/ellipse • Concept of volume
9. Solve problems using algebra	• Terminology • Transpose formulas • Transpose equations • Algebra calculations
10. Solve problems using metric and imperial units	• Terminology ○ Length, area and volume ○ Weight ○ Temperature • Metric and imperial conversion • Metric and imperial calculations

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	CONTENT

1. Describe types of friction	• Types of friction
	  ○ Rolling
	  ○ Sliding
	  ○ Fluid
	  ○ Starting
	• Causes of friction
	• Effects of friction

2. Describe oil lubrication	• Oil wedge • Boundary • Full film

3. Describe types of lubricants	• Types
	  ○ Grease
	  ○ Oil
	  ○ Synthetic oils

4. Describe various lubrication systems	• Automatic • Pressure • Gravity • Reservoir • Splash • Flinger • Manual • Capillary • Injector
5. Describe handling procedures	• 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	CONTENT

1. Identify layout tools	• Tools
	  ○ Measuring tape
	  ○ Gauge
	  ○ Level
	  – Spirit
	  – Optical
	  – Laser
	  ○ Transit
	  ○ Piano wire
	  ○ Plumb bob
	  ○ Straight edge
	  ○ Square

2. Describe equipment layout procedures	• Maintenance procedures
	• Layout procedures
	  ○ Machine location and alignment to associated equipment
	  ○ Machine bases
	  ○ 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
	  ○ Types of anchors
	  – Expansion shield
	  – Solid slug-ins
	  – Leaded
	  – Toggle
	  – Boxed bolts
	  – Hooks and tees
	  ○ Types of anchor bolts
	  – Fixed
	  – Pipe or tube
	  – Boxed
	  ○ Anchor installation
	  – Design bolts

LEARNING TASKS	CONTENT
	– 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 – Shims – Jacking screws

LEARNING TASKS	CONTENT
	– 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	CONTENT

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	CONTENT
3. Identify and use tools required for installation	• Wrenches • Slug wrenches • Hydraulic wrenches • Impact wrenches • Snap-ring pliers • Riveting devices
4. Describe methods and set torque values	• Torque wrenches • Hydraulic wrenches • Stretch method • Refer to service manuals

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

6. Apply methods of cutting threads and thread recovery	• Tools for cutting threads
	  ○ Taps
	  ○ Dies
	  ○ Thread gauges
	  ○ Threading machines
	  ○ Lathes
	• Repair methods for damaged threads
	  ○ Thread chasers
	  ○ Thread files
	  ○ Helicoil
	  ○ Other method

7. Select and use epoxies and resins	• Drying time
	• Material compatibility
	• Resistance
	  ○ Water
	  ○ Oil
	  ○ Other substances
	• Bonding strength
	• Resistance to impact and tension
	• Applications
	• Specifications

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.

LEARNING TASKS	CONTENT
1. Use service manuals to locate information	• Parts • Assembly/disassembly instructions • Equipment specifications • Lubrication specifications
2. Use industry reference, such as the Machinery's Handbook and IPT rotating equipment handbook to locate information	• Tolerances and fits of components • Parts • Cutting speeds • Material coefficients • Material characteristics
3. Use catalogues to locate information	• Inter-changeability of parts • Parts specifications • Equipment performance specifications
4. Use electronic media to locate information	• Parts and parts specifications • Inter-changeability of parts • Assembly/disassembly instructions • Equipment specifications • Equipment performance specifications • Lubrication specifications • Tolerances and fits of components • Cutting speeds • Material coefficients • Material characteristics • Running speeds
5. Use standard codes	• CSA • ASTM • ANSI • API

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	CONTENT
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	CONTENT
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

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	CONTENT

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	CONTENT
3. Identify layout tools and describe their purpose	• 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	• 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	CONTENT

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

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

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

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	CONTENT

1. Describe safe work practices welding and cutting	• Fire hazards
	• Safety regulations
	• Safety equipment
	• Fire watch
	  ○ Fire extinguishers
	  ○ Spotter requirements
	• Proper ventilation
	• Confined space
	• Unsafe equipment identification

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

3. Describe methods and safe work practices for heating	• Pre/post heating
	• Gas types and pressure
	  ○ Propylene
	  ○ Propane
	  ○ Acetylene
	  ○ Oxygen
	  ○ Natural gas

4. Use oxy-acetylene equipment	• Setup procedures
	  ○ Regulators
	  ○ Torches
	  ○ Hoses
	  ○ Cylinders
	  ○ Safety devices
	• Cutting
	  ○ Material identification
	  ○ Plate
	  ○ Sheet
	  ○ Round stock
	  ○ Rebar

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	CONTENT

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

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

3. Select, inspect and use wire rope	• Types and usage
	  ○ Fibre core
	  ○ 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	CONTENT
	• Chain • Fibre mesh • Synthetic fibre web • Wire mesh • Maintenance and storage
5. Select, inspect and use rigging attachments	• Spreader bars • Eye bolts • Hoist rings • Shackles • Hooks • End terminations • Turnbuckles • Blocks and pulleys • 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	CONTENT

1. Describe jurisdictional regulations	• Responsibilities of
	  ○ WorkSafeBC
	  ○ Employer
	  ○ Employee
	• Inspection requirements
	  ○ Annual
	  ○ 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
	  ○ Hand signals
	• Types of hand rigging equipment
	  ○ Jacks
	  ○ Come-a-longs
	  ○ Tirfors
	  ○ Chain hoists
	  ○ Winches
	• Rejection criteria
	• Maintenance and storage

3. Describe the use of cranes	• Types of cranes
	  ○ Overhead
	  ○ Conventional
	  ○ Mobile Hydraulic
	  ○ Tower
	  ○ Boom trucks
	  ○ Jib
	  ○ Gantry
	  ○ Hydraulic hoist
	• Jurisdictional regulations
	  ○ 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

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	CONTENT

1. Describe jurisdictional regulations	• Responsibilities of
	  ○ WorkSafeBC
	  ○ Employer
	  ○ Employee
	• Inspection requirements
	  ○ Annual
	  ○ Pre-use
	• Company specific requirement's (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

LEARNING TASKS

CONTENT

- Weather and ground conditions
- Site evaluation
- Post inspection

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

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	CONTENT

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

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

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

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

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

LEARNING TASKS	CONTENT

	• Calculations
	  ○ Work
	  ○ Power
	  ○ Horsepower
	  ○ Brake horsepower

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
13. Explain and perform calculations related to power transmission and motion	• Force ○ Weight

LEARNING TASKS

control systems

CONTENT

- 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	CONTENT

1. Describe types of friction	• Types of friction
	  ○ Rolling
	  ○ Sliding
	  ○ Fluid
	  ○ Starting
	• Causes of friction
	• Effects of friction

2. Describe oil lubrication	• Oil wedge theory • Boundary • Full film

3. Describe types and properties of lubricants	• Types of lubricants
	  ○ Grease
	  ○ Oil
	  ○ Synthetic oils
	• Properties and characteristics of grease
	  ○ Additives
	  ○ Soap
	  ○ Non-soap
	  ○ Multi-grease
	  – Multi-purpose grease
	  – Extreme pressure grease
	  ○ Mixed soap
	  ○ Grades
	  ○ Polar attraction
	  ○ Directional fluidity
	  ○ Selection process
	  ○ Compatibility
	• Properties and characteristics of oil
	  ○ Viscosity
	  – Kinematics
	  – Dynamic
	  – Index
	  ○ Grading systems
	  ○ Additives
	  ○ Inhibitors
	  ○ Classifications

LEARNING TASKS	CONTENT

4. Select lubricants for specific purposes	• Oil
	  ○ Advantages
	  ○ Disadvantages
	• Grease
	  ○ Advantages
	  ○ Disadvantages

5. Describe handling procedures	• Safe handling • WHMIS 2015 • Storage
6. Describe various lubrication systems	• Automatic • Pressure • Gravity • Reservoir • Splash • Flinger • Manual • Capillary • Injector

7. Maintain lubrication systems	• 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	CONTENT
1. Describe the leveling and alignment of components	• Shafts • Clutches • Belts • Chains • Gears

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	CONTENT

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

2. Identify properties of metals	• Tension • Compression • Torsion • Bending • Shearing • Safe load • Elastic limit • Yield point • Failure point

LEARNING TASKS	CONTENT
3. Describe the metallurgical properties of non-ferrous metals	• Aluminum • Copper • Brass • Bronze • Stainless steel • Chrome alloys • Manganese • Titanium
4. Describe the use and properties of non-metallic materials	• 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	CONTENT

1. Describe the metallurgical principles of ferrous metals	• Terminology
	  ○ Heat treatment
	  ○ Upper critical temperature
	  ○ Lower critical temperature
	  ○ Critical range
	  ○ Hardening
	  ○ Case hardening
	  ○ Tempering
	  ○ Annealing
	  ○ Normalizing
	  ○ Pearlite
	  ○ Ferrite
	  ○ Cementite
	  ○ Austenite
	  ○ Martensite
	• Hardening and tempering steels
	  ○ Preparation
	  ○ Heat and molecular changes
	  ○ Oxidation
	• Failure causes
	  ○ Fatigue
	  ○ Oxidation
	  ○ Stress cracking
	  ○ Corrosion
	  ○ 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	CONTENT
1. Describe how to assemble machines using drawings	• 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	CONTENT
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

2. Describe shielded metal arc welding equipment	• Associated equipment
	  ○ Electrode holders
	  ○ Ground clamps
	  ○ Cables
	• Electrodes
	  ○ SMAW electrodes
	  ○ Handling and storage
	  ○ Application selection

3. Perform shielded metal arc welding	• 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	CONTENT

4. Describe vertical shielded metal arc welding equipment	• Shut down
	• Associated equipment
	  ○ Electrode holders
	  ○ Ground clamps
	  ○ Cables
	• Electrodes
	  ○ Correct handling and storage
	  ○ Select for specific application

5. Perform vertical shielded metal arc welding	• 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	CONTENT
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

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

3. Describe theory and perform basic welding	• Basic joint design
	• Weld types, sizes and profiles
	• Welding positions
	  ○ Flat
	  ○ Horizontal
	  ○ Vertical
	• Weld faults
	  ○ Undercuts
	  ○ Porosity
	  ○ Inclusions
	  ○ Voids
	• Distortion control methods
	• Shut down

Achievement Criteria

Performance	The learner will be able to perform GMAW 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: 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	CONTENT
1. Explain principles of Gas Tungsten Arc Welding (GTAW / TIG)	• Principles of operation • Modes of metal transfer • Hard surfacing

2. Identify, set up and maintain welding equipment	• Power sources
	• Shielding gases
	• Gun assemblies
	• Equipment set up
	• Tungstens
	  ○ Types
	  ○ Sizes
	• Set up
	• Maintenance

3. Describe theory of basic welding	• Basic joint design
	• Weld types, sizes and profiles
	• Welding positions
	  ○ Flat
	  ○ Horizontal
	  ○ Vertical
	• Weld faults
	  ○ Undercuts
	  ○ Porosity
	  ○ Inclusions
	  ○ Voids
	• Distortion control methods
	• Shut down

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	CONTENT

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

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

LEARNING TASKS

CONTENT

- 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

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	CONTENT

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

2. Describe friction bearings	• Types
	  ○ Bushing
	  ○ Sleeve
	  ○ Split
	  ○ Precision insert
	  ○ Multi-part
	  ○ Half bearing
	• Housing styles
	  ○ Flange
	  ○ Pillow block
	  – Split
	  – Solid
	  – Angle
	  – Gib
	  ○ Integrated

3. Describe friction bearing materials	• Liner materials
	  ○ Metallic
	  – Babbitt
	  – Lead
	  – Bronze
	  – Sintered Bronze
	  – Brass

LEARNING TASKS	CONTENT
	– 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
4. Describe anti-friction bearings	• Construction ○ Rolling elements – Ball – Roller – Spherical – Cylindrical – Tapered roller ○ Containment rings – Inner ring – Outer ring – Separating mechanism – Split bearings ○ Miscellaneous parts – Seals – Shields ○ Mounting styles – Taper bore – Straight bore – Mounting sleeve – Withdrawal sleeve • Bearing codes
5. Select bearings based on application	• Friction • Anti-friction
6. Install and remove friction bearings	• Fitting methods ○ Hand scraping ○ Machine fitting ○ Hydraulic assist ○ Bluing • Clearance requirements ○ Installed ○ Running ○ Plastigauge®

LEARNING TASKS	CONTENT
	○ Lead wire • Positioning methods ○ Fixed ○ Floating ○ Locking rings ○ Hydraulic nut ○ Arbour press • Lubrication ○ Styles and position of lubrication grooves ○ Lubrication methods ○ Types of lubrication
7. Perform inspection and maintenance procedures on friction bearings	• Inspection ○ Visual ○ Sound ○ Temperature ○ Vibration ○ Lubrication • Repair methods ○ Liner material ○ Shafts ○ Housings
8. Install and remove anti-friction bearings	• Fits and tolerances ○ Dimensions ○ Unilateral and bilateral ○ Limit of size ○ Allowance ○ Radial and axial clearance ○ Pre-load • Allowances ○ Expansion fits ○ Shrink fits • 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 • Lubrication ○ Types ○ Methods

LEARNING TASKS	CONTENT
9. Perform inspection and maintenance procedures on anti-friction bearings	– 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.

LEARNING TASKS	CONTENT

1. Describe classes of sealing	• External and internal sealing
	  ○ Positive
	  ○ Non-positive
	  ○ Static
	  ○ Dynamic

2. Identify and describe gaskets	• Joints
	  ○ Unconfined
	  ○ Confined
	  ○ Partially confined
	  ○ Self confined
	  ○ Self energized
	• Gaskets
	  ○ Sealing
	  ○ Materials
	  ○ Installation
	  ○ Stamping (size)

3. Identify and describe packing	• Types
	  ○ O-rings
	  ○ V-packing
	  ○ U-section packing
	  ○ Cup packing
	  ○ Jam packing
	  ○ Compression packing

4. Describe mechanical seals	• Types
	  ○ Balanced
	  ○ Un-balanced
	  ○ Internal
	  ○ External
	  ○ Tandem
	  ○ Duplex
	• Materials
	  ○ Metallic
	  ○ Non-metallic

5. Identify and describe contact and non-contact seals	• Contact
	  ○ Lip seals
	  ○ Felt
	  ○ Finger
	  ○ Others

LEARNING TASKS	CONTENT

6. Select seals, gaskets and packing	• Non-contact
	  ○ Labyrinth
	  ○ Annulus
	  ○ Grease injected
	  ○ Others
	• Seals
	• Packing
	• Gaskets
	• Compatibility
	• Stamping (sizing)

7. Describe seal installation and maintenance procedures	• 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

Line (GAC): I SERVICE COUPLINGS, CLUTCHES AND BRAKES

Competency: I1 Select, install and maintain couplings

Objectives

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

- Identify different types of couplings.
- Assemble, install and maintain couplings.
- Recognize coupling failure and diagnose problems.

LEARNING TASKS	CONTENT

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

Line (GAC): I 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	CONTENT

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

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

3. Inspect brakes	• Safety requirements
	• Procedures
	  ○ Inspection
	  ○ Installation
	  ○ Removal
	  ○ Testing
	  ○ Intermittent
	  ○ 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	CONTENT

1. Describe drive chains	• Terminology
	  ○ Roller link
	  ○ Plate link
	  ○ Offset link
	  ○ ANSI
	  ○ ISO
	  ○ Chain codes
	  ○ Bushing
	  ○ Sprocket
	  ○ Slack
	  ○ Idler
	  ○ Pitch
	  ○ 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	CONTENT

1. Describe belt drives	• Terminology
	  ○ Tension
	  ○ Arc of contact
	  ○ Area of contact
	  ○ Creep
	  ○ Pitch line
	  ○ Idler
	  ○ Compression section
	  ○ Tension section
	  ○ Pitch
	  ○ Coefficient of friction
	  ○ Neutral section
	  ○ Ply
	  ○ Sheaves
	  ○ Pulley
	  ○ Elongation
	  ○ Rim speed
	• Belt drive operation principles
	  ○ Area of contact
	  ○ Belt tension
	  ○ Friction
	  ○ Belt to pulley
	  ○ Belt to sheave
	  ○ Guidelines
	  ○ Belt speed
	  ○ Power record keeping
	• Advantages and disadvantages
	  ○ Flat belts
	  ○ V-belts

2. Describe flat belt drive systems	• Belts
	  ○ Types
	  – Positive drive
	  – Leather
	  – Serpentine
	  ○ Identification
	  ○ Construction
	  ○ Joining
	  – Vulcanized
	  – Mechanical fasteners

LEARNING TASKS	CONTENT
	– 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
3. Describe V-belt drive systems	• 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
4. Perform belt drive calculations	• Speeds ○ Ratios ○ Simple reductions ○ Compound reductions ○ Belt velocity ○ RPM • Belt installation ○ Arc of contact ○ Belt length ○ Tension ○ Center distance
5. Install and maintain belt drives	• Drive installation ○ Alignment ○ Belt selection ○ Belt adjustment ○ Belt tension adjustment devices ○ Sheave installation

LEARNING TASKS	CONTENT

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

6. Describe variable speed drives	• Variable speed belts
	  ○ Types
	  ○ Profiles
	  ○ Codes
	• Types of variable speed sheaves
	  ○ Compound
	  ○ Spring loaded
	  ○ Installation
	• Variable speed drives
	  ○ Identification
	  ○ Hub forces
	  ○ Principle of operation
	  – Cone drives
	  – Metal belts
	  – Geared differential drives
	  – Traction drives

7. Maintain variable speed drives	• Lockout • Safety precautions • Adjustments • Drive installation • Sheave maintenance • Belt inspection

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	CONTENT

1. Describe gear terminology	• Associated with gears
	  ○ Addendum
	  ○ Dedendum
	  ○ Circular pitch
	  ○ Whole depth
	  ○ Outside diameter
	  ○ Pitch circle diameter
	  ○ Clearance
	  ○ Pitch circle
	  ○ Line contact
	  ○ Root diameter
	  ○ Pressure angle
	  ○ Pitch
	  ○ Working depth
	  ○ Hand
	  ○ Involute
	• Associated with reduction units
	  ○ Back lash
	  ○ Hand
	  ○ Mesh
	  ○ Compound reduction
	  ○ Idler gears
	  ○ Contact

2. Describe and identify characteristics of gears	• Types
	  ○ Spur
	  ○ Rack and pinion
	  ○ Internal spur
	  ○ Helical
	  ○ Herring bone
	  ○ Bevel
	  ○ Worm and wheel
	  ○ Hypoid
	  ○ Spiral bevel

LEARNING TASKS

CONTENT

- Planetary
- Cycloid

- Shaft positions for different gears
  - Parallel
  - Intersecting
  - Crossing
- 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	CONTENT

1. Describe gear drives and reduction units	• Identification
	  ○ Types
	  ○ Hand
	• Installation
	  ○ Mounting
	  – Alignment
	  – Permanent location
	  – Shaft mounted
	  ○ Attachments
	  ○ Assembly
	  ○ Inspection
	• Lubrication
	  ○ Methods
	  ○ Inspection
	• Bearings
	  ○ Types
	  ○ End float
	  ○ Clearance
	• Seals
	  ○ Location
	  ○ Installation

2. Inspection of gear drives	• Safety
	  ○ Precautions
	  ○ Guards
	• Inspection
	  ○ Reduction unit dismantling
	  ○ Dowels
	  ○ Noise
	  ○ Vibration
	  ○ Heat
	  ○ Lubrication
	  ○ Wear patterns
	  ○ Backlash
	  ○ Effects

LEARNING TASKS	CONTENT
	– Bearings – Seals • Gear mesh ○ Backlash ○ Gear contact ○ Wear patterns

Achievement Criteria

Performance	The learner will be able to disassemble and assemble gear/boxes.
Conditions	The learner will be given: • PPE • Components • Tools • Work bench • Reference resources
Criteria	The learner will be evaluated on: • Safety • Cleanliness • Correct assembly • Fit and clearances

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
	  ○ Taper
	  ○ Feeler
	• Shims
	• Calipers
	  ○ Inside
	  ○ Outside

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

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

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

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

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 rim and face dial alignment.

LEARNING TASKS	CONTENT

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
	  ○ Rolls

LEARNING TASKS	CONTENT
6. Demonstrate alignment procedures and record keeping	○ 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	CONTENT

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

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

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

4. Describe the principles of fluid power	• Laws and Principles
	  ○ Pascal's Law
	  ○ Bernoulli's Principle
	  ○ Newton's Law of conservation of energy

LEARNING TASKS	CONTENT
	○ Multiplication forces • Terminology ○ Hydrodynamic ○ Hydrostatic ○ Atmospheric pressure ○ Suction ○ Head ○ Cavitation ○ Lift • Vacuum and pressure measurements • Input-output components • Advantages and disadvantages ○ Hydraulics vs. other power sources
5. Explain the relationship of flow and flow paths	• Fluid flow • Creation of pressure • Series flow paths • Parallel flow paths • Pressure drop • Laminar and turbulent flow
6. Use fluid power calculations	• Pneumatic • Hydraulic • Vacuum

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	CONTENT
1. Describe the leveling and alignment of components	• 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	CONTENT

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

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

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

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	CONTENT

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

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 cross dial and graph alignment	• Alignment formulae
	• Graph and plot
	• Equipment alignment procedures
	  ○ Alignment tools
	  ○ Shims
	  ○ Jacking screws

5. Use equipment alignment procedures	• Alignment equipment
	  ○ Various types
	  ○ Selection
	  ○ Checking and maintaining
	  ○ Care
	  ○ Mounting
	  ○ Shims
	  ○ Jacking screws

LEARNING TASKS	CONTENT

6. Demonstrate alignment procedures and record keeping	• 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	CONTENT

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

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 laser alignment	• Equipment alignment procedures
	  ○ Alignment tools
	  ○ Shims
	  ○ Jacking screws

5. Use equipment alignment procedures	• Alignment equipment
	  ○ Various types
	  ○ Selection
	  ○ Checking and maintaining
	  ○ Care
	  ○ Mounting
	  ○ Shims
	  ○ Jacking screws
	• Machine component procedures
	  ○ Rough alignment
	  ○ Rolls

LEARNING TASKS	CONTENT
	○ Hubs ○ Bearings ○ Sprockets ○ Sheaves
6. Demonstrate alignment procedures and record keeping	• 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	CONTENT

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

2. Describe the maintenance and service of fans	• 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

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	CONTENT
1. Describe types of blowers	• Centrifugal • Lobe • Screw

2. Describe the maintenance and service of blowers	• Safe work practices
	• Ventilation and pollution control
	  ○ Jurisdictional regulations
	  ○ Scrubbers
	  ○ Electrostatic precipitators
	  ○ Bag house
	  ○ Cyclonic separators
	• Service manuals
	• Specifications
	• Maintenance checks
	  ○ Alignment
	  ○ Vibration
	  ○ Wear
	  ○ Noise
	  ○ 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	CONTENT

1. Describe the theory of pump operation	• Terminology
	  ○ Static
	  – Lift
	  – Head discharge head
	  – Suction head
	  ○ Dynamic
	  – Lift
	  – Head discharge head
	  – Suction head
	  ○ Total head
	  ○ Cavitation
	  ○ Positive displacement
	• Operating principles and basic theory
	  ○ Positive displacement
	  ○ Relationship of pressure and flow
	  ○ Pump calculations

2. Identify and select different styles of pumps	• Styles of pumps
	  ○ Positive displacement
	  ○ Multi-stage
	  ○ Single stage
	  ○ Advantages/disadvantages/application
	  – Multi stage
	  – Single stage
	• Major components
	  ○ Positive displacement
	• Application of different types of pump materials
	  ○ Cast iron
	  ○ Stainless steel
	  ○ Rubber
	  ○ Plastic
	  ○ Exotic metals

LEARNING TASKS

CONTENT

- Pump selection
  - Limitations
  - Condition of flow
  - Pulsation
  - 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	CONTENT

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

Line (GAC): N SERVICE PUMPS

Competency: N3 Identify and select non-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 non-positive displacement pump operation.
- Identify and select non-positive displacement pumps.

LEARNING TASKS	CONTENT

1. Describe the theory of pump operation	• Terminology
	  ○ Static
	  – Suction lift
	  – Discharge head
	  – Suction head
	  ○ Dynamic
	  – Suction lift
	  – Discharge head
	  – Suction head
	  ○ Total head
	  ○ Cavitation
	  ○ Non-positive displacement
	• Operating principles and basic theory
	  ○ Non-positive displacement
	  ○ Relationship of pressure and flow
	  ○ Pump calculations

2. Identify and select different styles of non-positive displacement pumps	• Styles of pumps
	  ○ Non-positive displacement
	  ○ Multi-stage
	  ○ Single stage
	  ○ Advantages/disadvantages
	  – Multi stage
	  – Single stage
	  ○ Application
	  – Multi stage
	  – Single stage
	• Major components
	  ○ Non-positive displacement
	• Applications of pump materials
	  ○ Cast iron
	  ○ Stainless steel

LEARNING TASKS	CONTENT
	○ Rubber ○ Plastic ○ Exotic metals • Pump selection ○ Limitations ○ Condition of flow ○ Pulsation ○ Structural considerations ○ Products pumped – Hydro carbons – Corrosives – Water – Slurries – Pulpy solids – High temperature products

Line (GAC): 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	CONTENT

1. Describe and perform maintenance of non-positive displacement pumps	• Specifications
	  ○ Displacement capacity
	  ○ Lift capacity
	  ○ Static head
	• Installation and leveling
	• Maintenance
	  ○ Alignment
	  ○ Sealing
	  ○ Lubrication
	  ○ Removing air

2. Describe troubleshooting non-positive displacement pumps	• 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

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

Line (GAC): O SERVICE COMPRESSORS

Competency: O1 Identify and select compressors

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	CONTENT

1. Describe the application of compressors in industrial settings	• Industries
	  ○ Oil
	  ○ Gas
	  ○ Refrigeration
	  ○ Air conditioning
	  ○ Instrument air
	  ○ Mining
	  ○ Pulp and paper
	  ○ Wood manufacturing
	  ○ Miscellaneous manufacturing industries

2. Describe the major classifications of compressors	• Positive displacement • Non-positive displacement

3. Identify types and styles of compressors	• Reciprocating
	  ○ Piston
	  ○ Free piston
	  ○ Diaphragm
	  ○ Cross-head
	  ○ Trunk
	• Rotary
	  ○ Vane
	  ○ Screw
	  ○ Lobe
	• Dynamic
	  ○ Centrifugal
	  ○ Axial

4. Describe positive displacement compressor theory	• Positive displacement compressor operating principles
	  ○ Safety requirements
	  ○ Compression ratios
	  ○ Energy requirements
	  ○ Use in industry

5. Describe non-positive displacement compressor theory	• 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	CONTENT

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

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

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	CONTENT

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	• Agitators • Vents • Pumps • Level indicators

3. Describe troubleshooting of process tanks and containers	• Problems and symptoms
	• Inspect components
	  ○ Filters
	  ○ Strainers
	  ○ Piping
	  ○ Agitators
	  ○ Vents
	  ○ Monitoring systems
	• NDT or condition-based monitoring
	  ○ Requirements
	• Type of repairs
	  ○ Patching
	  ○ Overlay
	  ○ Re-coating
	  ○ Piping
	• Failure or breakdown conditions

4. Describe repair procedures for process tanks and containers	• Tools and equipment

LEARNING TASKS	CONTENT

5. Describe maintenance procedures for process tanks and containers	• Safety procedures
	  ○ Confined space
	• Components
	  ○ Dimension measurements
	  ○ Adjust
	  ○ Lubricate
	  ○ Defective
	  – Refurbish
	  – Replace
	• Type of repairs
	  ○ Patch
	  ○ Overlay
	  ○ Re-coat
	  ○ Piping
	• 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

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	CONTENT

1. Describe types of piping systems and their components	• Process
	• Tubing
	  ○ Instrumentation
	  ○ Cooling water
	  ○ Flush water
	• Sealing fluid
	• High/low pressure
	• Components
	  ○ Cyclones
	  ○ Separators
	  ○ Pollution control equipment
	  ○ Agitators
	  ○ Vents
	  ○ 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
	  ○ Filters
	  ○ Strainers
	  ○ Piping
	  ○ Vent
	  ○ Monitoring system
	• NDT or condition-based monitoring requirements
	• Type of repairs
	  ○ Patch
	  ○ 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

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	CONTENT

1. Identify and describe hydraulic fluids	• Fluid bases
	  ○ Petroleum mixtures
	  ○ Synthetic fire resistant fluids
	  ○ Storage and handling
	• Qualities
	  ○ Power transmission
	  ○ Lubrication
	  ○ Sealing
	  ○ Cooling
	• Fluid additives
	• Viscosity
	• Oxidation catalysts

2. Describe fluid conditioners	• Identify
	  ○ Filters
	  ○ Strainers
	  ○ Filtering materials
	• Mesh and micron ratings
	• Filter and strainer position effectiveness
	• Full flow and proportional filtering methods
	• Heat exchangers

3. Describe fluid conductors	• Piping
	  ○ Sizes
	  ○ Types
	  ○ Schedules
	  ○ Fittings
	  ○ Sealing
	  ○ Compatibility with fluids
	  ○ Applications
	  ○ Installation
	• Tubing
	  ○ Sizes
	  ○ Types
	  ○ Measurement
	  ○ Fittings
	  ○ Compatibility with fluids
	  ○ Applications
	  ○ Installation

LEARNING TASKS	CONTENT

	• Hoses
	  ○ Parts
	  ○ Construction
	  ○ Pressure and flow considerations
	  ○ Types of fittings
	  ○ Compatibility with fluids
	  ○ Applications
	  ○ Installation
	• Sealing
	  ○ Internal
	  ○ External
	  ○ Types of seals
	  ○ Static seals
	  ○ Dynamic seals
	  ○ Considerations for leak prevention

4. Describe reservoirs	• Styles of reservoirs
	  ○ Conventional
	  ○ Overhead
	  ○ L-shaped
	• Components
	  ○ Baffle plates
	  ○ Breather
	  ○ Sight glass
	  ○ Filler hole
	  ○ Drain plug
	  ○ Magnetic plug
	  ○ Paint sealer
	  ○ Temperature gauge
	  ○ Removable cover
	• Size requirements

5. Describe actuators	• Rotary
	  ○ Gear
	  ○ Vane
	  ○ Piston
	  ○ Construction
	  ○ Displacement
	  ○ Torque rating
	• Linear
	  ○ Single acting
	  ○ Double acting
	  ○ Differential
	  ○ Non-differential
	  ○ Ram
	  ○ Telescoping construction
	  ○ Load
	  ○ Speed
	  ○ Mounting styles

6. Describe hydraulic valves	• Check valves • Directional control valves ○ Classifications

LEARNING TASKS	CONTENT
	○ Spool types ○ Methods of operation • Servo valves • Pressure actuated valves ○ Relief ○ Unloading ○ Sequence ○ Pressure reducing ○ Brake ○ Location ○ Operation • Volume control valves
7. Describe hydraulic accessories	• Accumulators ○ Purpose ○ Weighted ○ Spring ○ Gas charged • Intensifiers ○ Purpose ○ Function • Switches ○ Purpose ○ Function ○ Styles • Gauges ○ Purpose ○ Function ○ Styles
8. Describe hydraulic pumps	• 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 ○ Flow rate ○ 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	CONTENT
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	CONTENT
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

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	CONTENT

1. Describe pneumatic conductors	• Piping
	  ○ Terminology
	  – Pipe diameter
	  – Rate of flow
	  – Turbulence
	  – Friction
	  – Wall thickness
	  – Bursting pressure
	  – Safety factors
	  ○ Types
	  ○ Thread and seal types
	• Tube
	  ○ Types
	  – Carbon steel
	  – Stainless steel
	  – Copper
	  – Aluminum
	  – Plastic
	  ○ Installation
	  ○ Measuring
	  ○ Bending ratio
	  ○ Fittings
	• Hose
	  ○ Parts
	  ○ Types
	  ○ Pressure rating
	  ○ Fittings
	  ○ Installation

2. Describe pneumatic valves	• Valve functions
	  ○ Starting flow
	  ○ Stopping flow
	  ○ Preventing back flow
	  ○ Regulating pressure
	  ○ Relieving pressure
	  ○ Timing
	• Valve types
	  ○ Gate
	  ○ Glove
	  ○ Check
	  ○ Plug

LEARNING TASKS	CONTENT
	○ Diaphragm ○ Needle ○ Butterfly ○ Safety ○ Relief ○ Regulator ○ Time delay ○ Quick exhaust ○ AND valve ○ OR valve ○ Directional control ○ Pressure regulators
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 • Operation ○ Single acting

LEARNING TASKS

8. Identify components associated with vacuum systems

CONTENT

- 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	CONTENT

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

Line (GAC): R SERVICE PNEUMATIC AND VACUUM SYSTEMS

Competency: R3 Maintain and repair pneumatic and vacuum systems

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	CONTENT
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	CONTENT

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	CONTENT
1. Estimate labour requirements	• Task analysis • Work estimate • Time estimate

2. Schedule work	• Work activity plan
	  ○ Safe work plan
	  ○ Rigging plan
	• Coordinate with other trades
	• Effective communication
	  ○ Verbal
	  ○ Written
	• Interpersonal skills

3. Identify and estimate materials and tools and equipment requirements	• Material calculation ○ Request forms • Tools and equipment • Delivery coordination • Documentation

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	CONTENT
1. Describe the leveling and alignment of components	• 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
	  ○ ANSI (American National Standards Association)
	  ○ ISO (International Standards Organization)
	  ○ NEMA (National Electrical Manufacturer's Assoc.)

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

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 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	CONTENT
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	CONTENT
1. Describe methods for mentoring and guiding the learning of apprentices to defined standards.	• Learning styles • Instruction methods • Confirm student comprehension • Break down a large body of knowledge into smaller learning tasks

2. Use effective communication techniques.	• Communication skills
	  ○ Clarity
	  ○ Concise
	  ○ Body language
	  ○ 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	CONTENT

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
	• Idlers

LEARNING TASKS	CONTENT
	○ 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
4. Identify bucket elevators and components	• Components ○ Belts ○ Case ○ Chain ○ Buckets ○ Pulleys ○ Drives • Styles of conveyors ○ Centrifugal discharge ○ Positive discharge ○ Continuous discharge ○ Super capacity
5. Identify screw conveyors and components	• Terminology ○ Pitch ○ Lead ○ Helix angle ○ Flights • Components ○ Screw ○ Trough ○ Bearings ○ Hangers ○ Drives ○ Accessories
6. Identify chain conveyors and components	• Components ○ Chain types ○ Sprockets ○ Drums ○ Attachments ○ Troughs

LEARNING TASKS	CONTENT
	○ Take ups ○ Drives • Styles ○ Long link ○ Double strand ○ Refuse ○ Drag ○ Flight ○ Miscellaneous
7. Identify pneumatic conveying systems	• Terminology ○ Low pressure ○ Medium pressure ○ High pressure ○ Vacuum ○ Fluidized • System components ○ Blowers ○ Feeders ○ Cyclones ○ Blow pipe
8. Identify roller conveyors and components	• Gravity powered ○ Components ○ Load ratings • Powered roller conveyors ○ Components ○ Belt position ○ Drive position ○ Load rating
9. Identify roll case conveyors and components	• Types ○ Standard (transfer) ○ Bottle ○ Eccentric (off centre) ○ Guide • Components ○ Rolls ○ Drives ○ Accessories
10. Identify transfer table conveyors and components	• Types • Components ○ Drives ○ Tracks ○ Chain ○ Belt ○ Slack controllers ○ Lifts – Hydraulic – Pneumatic
11. Identify monorail systems and their components	• Types • Components ○ Rails

LEARNING TASKS	CONTENT
12. Describe methods of loading and unloading conveyors	○ 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
  - Gravity
  - 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.

LEARNING TASKS	CONTENT
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
4. Describe the maintenance of chain conveyors	• Safety requirements

LEARNING TASKS	CONTENT
	• Chain wear • Sprocket wear • Alignment • Lubrication • Tensioning devices • Troubleshooting
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

LEARNING TASKS	CONTENT

10. Service conveying systems	• Covers and troughs
	• Lubrication
	• Troubleshooting
	• Belt
	• Bucket elevator
	• Screw conveyor
	• Chain conveyors
	• Pneumatic conveying systems
	• Roller conveyors
	• Roll case conveyors
	• Transfer tables
	• Monorail systems
	• Water
	  ○ Gravity
	  ○ 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

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	CONTENT
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	CONTENT

6. Maintain and troubleshoot electric motors	• Multimeter
	• Megger
	• Safety requirements
	• Malfunction diagnosis
	  ○ Ground faults
	  ○ Short circuits
	  ○ Overloads
	  ○ Connection
	  ○ Disconnection
	  ○ Overload protection devices
	• Maintenance
	  ○ AC motors
	  ○ DC motors

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	CONTENT

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	CONTENT

1. Describe the operating principles of turbines	• Turbine theory
	  ○ Impulse
	  ○ Reaction
	  ○ Combination
	• Types
	  ○ Gas
	  ○ Hydro
	  ○ Steam
	  ○ Wind

2. Identify and describe turbine components	• Steam
	  ○ Valves
	  ○ Nozzles
	  ○ Buckets
	  ○ Shaft
	  ○ Seals
	  ○ Governors
	  ○ Blades
	  ○ Bearings
	  ○ Rotors
	  ○ Speed controls
	  ○ Positioning devices
	• Gas
	  ○ Compressors
	  ○ Combustors
	  ○ Turbine/rotor
	  ○ Fuel
	• Hydro
	  ○ Runners
	  ○ Control mechanisms
	  ○ Pen stocks
	• Wind
	  ○ Tower
	  ○ Nacelle
	  ○ Generator
	  ○ Gearbox
	  ○ Blades

3. Identify and use tools and equipment for turbines	• Vibration meters

LEARNING TASKS	CONTENT

4. Describe maintenance and troubleshooting of turbines	• 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

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	CONTENT
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
	  ○ Breakdown maintenance
	  ○ Predictive maintenance (PDM)

LEARNING TASKS	CONTENT
	– computerization of records keeping (CMMS) ○ Preventative maintenance (PM)
6. Describe fluid analysis methods	• Ferrography • Spectrography • Viscosity • Particle count • Filter patch
7. Describe the steps to troubleshoot for equipment deficiencies	• Machine knowledge • Schematic • Service manuals • Operator • Possible causes • Conclusion ○ Test

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	CONTENT

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

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

3. Analyze vibration test data	• Test equipment • Data recording systems

LEARNING TASKS

CONTENT

- 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
  - Application
  - Equipment
- Pre-balance procedures and requirements
- Balancing methods
  - Static/dynamic
  - 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
  - Types
  - Limitations
- Ultrasonic testing
  - Applications
  - Advantages and disadvantages
  - Certification required
- Radiography testing
  - Applications
  - Advantages and disadvantages
  - Safety requirements
  - Types of equipment
  - Certification required
- Mechanical particle testing
  - Application
  - Advantages and disadvantages
  - Methods of use
  - Limitations
  - Type of defects located
  - Equipment required
- Infrared testing
  - Application
  - Equipment
  - Advantages and disadvantages
  - Limitations
- Visual testing
  - Application
  - Equipment
  - Advantages and disadvantages
- Temperature monitoring equipment
  - Temperature probes
  - 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	CONTENT
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
	• Categorize

LEARNING TASKS

CONTENT

- Warranty
- Design

- Commissioning improvement recommendations

Achievement Criteria

Performance	The learner will be able to use provided resources for a simulated commissioning of equipment.
Conditions	The learner will be given: • Scenario • Reports, records and data • Reference resources
Criteria	The learner will be evaluated on: • Safety • Accuracy

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	CONTENT

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	CONTENT

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

Tools and Equipment

Hand Tools

- Bench vise
- Breaker bar
- Broaches
- Burrs
- Calculator
- C-clamp
- Chemical locking products
- Chisel
- Dies
- Files
- Hammers
  - Ball peen
  - Claw
  - Mallet
  - Shaping
  - Sledge
  - Soft faces mallet
- Helicoil
- Hone
- Machinist clamp
- Mechanical lubricators
- Packing pullers
- Pliers
  - Angle cutters
  - Linesman
  - Locking
  - Needle nose
  - Side cutters
  - Slip joint
  - Snap ring
  - Water pump
- Pullers (3 leg, 2 leg)
- Reamers
- Riveting tools
- Rod (guillotine) puller
- Rotary files
- Saws
  - Hacksaws
  - Hand saw (wood)
  - Rod saws
- 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
- Pneumatics
  - Conductors
  - Directional control valves
  - Pressure relief valves
  - F-R-L units
  - Compressors/pumps
  - Actuators
  - Receivers
  - Dryers
  - Circuit boards
- Prime movers
  - Electric motors
    - AC motors
    - DC motors
  - Internal combustion engines
    - Compression ignition engines
  - Spark ignition engines
  - Turbines
    - Steam turbine
    - Gas turbine
    - Hydraulic turbine
- Vacuum systems
  - Vacuum pumps
  - Valves
  - Actuators
  - Filters
  - Compressors
  - Positive displacement
  - Non-positive displacement
  - Gauges
- Pumps
  - Positive displacement
  - Non-positive displacement

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

Appendices

APPENDIX A

Assessment Guidelines

Level 1 Grading Sheet: Subject Competency and Weightings

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

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	PERFORM SAFETY RELATED FUNCTIONS	20%	0%
B	USE TOOLS AND EQUIPMENT	15%	0%
C	PERFORM ROUTINE TRADE ACTIVITIES	15%	25%
D	USE COMMUNICATION AND MENTORING TECHNIQUES	5%	0%
E	PERFORM MEASURING AND LAYOUT OF WORK PIECE	15%	25%
F	PERFORM CUTTING AND WELDING OPERATIONS	10%	25%
G	PERFORM RIGGING, HOISTING/LIFTING AND MOVING	20%	25%
	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 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 2

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

PROGRAM: IN-SCHOOL TRAINING:	INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 3		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
C	PERFORM ROUTINE TRADE ACTIVITIES	10%	0%
L	PERFORM SHAFT ALIGNMENT PROCEDURES	12%	20%
M	SERVICE FANS AND BLOWERS	12%	0%
N	SERVICE PUMPS	15%	20%
O	SERVICE COMPRESSORS	12%	0%
P	SERVICE PIPING, TANKS AND CONTAINERS	12%	20%
Q	SERVICE HYDRAULIC SYSTEMS	15%	20%
R	SERVICE PNEUMATIC AND VACUUM SYSTEMS	12%	20%
	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 4 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	INDUSTRIAL MECHANIC (MILLWRIGHT) LEVEL 4

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
C	PERFORM ROUTINE TRADE ACTIVITIES	10%	0%
D	USE COMMUNICATION AND MENTORING TECHNIQUES	5%	0%
S	SERVICE CONVEYING SYSTEMS	21%	50%
T	SERVICE PRIME MOVERS	28%	0%
U	PERFORM PREVENTATIVE AND PREDICTIVE MAINTENANCE	21%	0%
V	PERFORM COMMISSIONING AND DECOMMISSIONING OF EQUIPMENT	10%	50%
W	SERVICE ROBOTICS AND AUTOMATED EQUIPMENT	5%	0%
	Total	**100%**	**100%**
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 SkilledTradesBC CofQ exam.	IN-SCHOOL %

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.

SkilledTradesBC will enter the apprentices' Industrial Mechanic (Millwright) Interprovincial examination mark in SkilledTradesBC Portal. 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

ABS:	Acrylonitrile butadiene styrene (type of plastic)
Adjust:	To bring to a more satisfactory state. To bring the parts of to a true or more effective relative position.
Align:	To bring into alignment.
Analyze:	To examine critically so as to determine appropriate procedures, process, or course of action.
ANSI:	American National Standards Association
Apply:	To put to use especially for some practical purpose.
Assemble:	To fit together the parts of.
Assess:	To determine the value, significance, or extent of; appraise.
Calculate:	To arrive at a precise numerical answer – often through the use of mathematical formulas.
CMMS:	Computerized maintenance management system
Construct:	To make or form by combining or arranging parts or elements.
CPM:	Critical Path Method
Define:	To set forth the meaning of a word or expression.
Demonstrate:	To exhibit, show clearly or perform, to a competency standard, a process or competence.
Describe:	To set forth the properties or characteristics of an object. To give a detailed or graphic account of a process or procedure. (To use correct terminology, sequencing and inter-relationship of the elements is implied where required.)
Determine:	To arrive at, or locate, information by a simple process (e.g. by rule of thumb).
Explain:	To show the logical development or relationships of.
Evaluate:	To determine the significance, worth, or condition of usually by careful appraisal and study.
HDPE:	High-density polyethylene
Identify:	To use the correct terminology to describe objects, both individually and collectively; to state their application or use, and to point out and name them.
Inspect:	To look into, or at carefully. To examine, or observe, critically in order to detect flaws, errors, etc.
Install:	To set up for use or service.
ISO:	International Standards Association
JIC:	Joint Industry Conference
Jurisdictional regulations:	Includes ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS 2015), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), and municipal
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

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 Muzylowski — West Fraser (Eurocan Pulp and Paper)
- James Piwek — Teck
- Brad Smith — Catalyst Paper
- Cindy Soderstrom — CAODC (Rig Tech Trade)
- Gene Von Matt — Elk Valley Coal
- Wayne Wetmore — Enform Training
- Trevor Williams — 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