



PROGRAM OUTLINE

Heavy Duty Equipment Technician

Implementation date: April 1, 2024

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HEAVY DUTY EQUIPMENT TECHNICIAN PROGRAM OUTLINE

APPROVED BY INDUSTRY

MARCH 2023

IMPLEMENTATION DATE

APRIL 1, 2024

THIS BC PROGRAM HAS BEEN HARMONIZED AND IS BASED ON RSOS 2022

**Developed by
SkilledTradesBC
Province of British Columbia**

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Section 1 INTRODUCTION

Heavy Duty Equipment Technician

Foreword

A Heavy Duty Equipment Technician is a tradesperson who possesses the full range of knowledge, abilities and skills required to diagnose, repair, adjust, overhaul, maintain, operate and test the mobile, heavy duty machinery used in the construction, forestry, mining, petrochemical, material handling, landscaping, land clearing, transportation, road building and farming sectors.

Heavy Duty Equipment Technicians inspect bulldozers, articulated trucks, haul trucks, cranes, graders, drills and other heavy equipment for proper performance. They also inspect equipment to detect and diagnose faults and malfunctions to determine the extent of the repair required. Heavy Duty Equipment Technician service engines and engine support systems, hydraulic systems, pneumatics, and drive trains. Other duties include adjusting equipment, welding and cutting, repairing or replacing defective parts, components or systems, using hand and power tools and diagnostic test equipment.

Heavy Duty Equipment Technicians work in the full range of environmental conditions; from comfortable shops to remote sites where inclement weather can be a factor. Shift work is common. Good physical condition is important because the work often requires considerable standing, bending, crawling, lifting, climbing, pulling and reaching.

Due to the size and complexity of the equipment, safety is of prime importance. Heavy Duty Equipment Technicians must be conscious of the impact on people, equipment, work area and environment when performing their work.

Some important attributes of the Heavy Duty Equipment Technician are:

- Reliability
- Analytical skills
- Ability to read and understand service manuals
- Mathematical aptitude

They also demonstrate the ability to:

- Communicate effectively
- Work with little or no supervision
- Contribute to a team approach
- Plan and work sequentially
- Adapt to changing technology
- Problem solve

Key attributes for people entering this trade are mechanical aptitude, manual dexterity, hand-eye coordination, stamina and agility. Communication skills and patience are also important. Other assets are good vision, hearing and sense of smell to diagnose problems. This occupation may require a valid driver's license with air endorsement and/or a forklift operator's certificate.

This revised Program Outline is intended as a guide for instructors, apprentices, and employers of apprentices as well as for the use of industry organizations, regulatory bodies, and provincial and federal governments. It reflects updated standards based on the 2022 Red Seal Occupational Standard (RSOS). It was developed by British Columbia industry and instructor subject matter experts.

Practical instruction by demonstration and student participation should be integrated with classroom sessions. Safe working practices, even though not always specified in each operation or topic, are an implied part of the program and should be stressed throughout the apprenticeship.

This Program Outline includes a list of recommended reference textbooks that are available to support the learning objectives and the minimum shop requirements needed to support instruction.

Competencies are to be evaluated through written exams and practical assessments. A passing grade is achieved by getting an overall mark of 70%. See the Assessment Guidelines in Section 4 for more details.

Achievement Criteria are included for competencies that require a practical assessment. The intent of including Achievement Criteria in the Program Outline is to ensure consistency in training across the many training institutions in British Columbia. Their purpose is to reinforce the theory and to provide a mechanism for evaluation of the learner's ability to apply the theory to practice. It is important that these performances be observable and measurable and that they reflect the skills spelled out in the competency. The conditions under which these performances will be observed and measured must be clear to the learner as well as the criteria by which the learner will be evaluated. The learner must also be given the evaluation criteria.

The performance spelled out in the Achievement Criteria is a suggested performance and is not meant to stifle flexibility of delivery. Training providers are welcome to substitute other practical performances that measure similar skills and attainment of the competency. Multiple performances may also be used to replace individual performances where appropriate.

SAFETY ADVISORY

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

Acknowledgements

Industry and Instructor Subject Matter Experts retained to assist in the development and review of this Program Outline:

- | | | |
|------------------|-----------------|---|
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Previous Contributors

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| • T. Lockhart | Instructor | Okanagan College (OC) |
| • R. Tremblay | Instructor | Northern Lights College (NLC) |
| • C. Hull | Instructor | College of New Caledonia (CNC) |
| • G. Warne | Instructor | British Columbia Institute of Technology (BCIT) |

SkilledTradesBC would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Heavy Duty Equipment Technician 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	Communicates program length and structure, and all pathways to completion	Illustrates the length and structure of the program	Illustrates the length and structure of the program, and pathway to completion	Illustrates the challenger pathway to Certificate of Qualification
OAC	Communicates the competencies that industry has defined as representing the scope of the occupation	Displays the competencies that an apprentice is expected to demonstrate in order to achieve certification	Displays the competencies apprentices will achieve as a result of program completion	Displays the competencies challengers 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	Shows 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	Shows 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	Shows 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, measurable 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
Assessment Guidelines	Shows the general areas of competency covered in each level of technical training, the theory and practical grading weight, and the calculation method for final percentage marks	Shows the general areas of competency covered in the technical training, the grading weight for each GAC, and the percentage of that time spent on theory versus practical application	Shows the general areas of competency covered in each level of technical training, the theory and practical grading weight, and the calculation method for final percentage marks	Shows the relative weightings of various general areas of competency within the occupation on which assessment is based

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

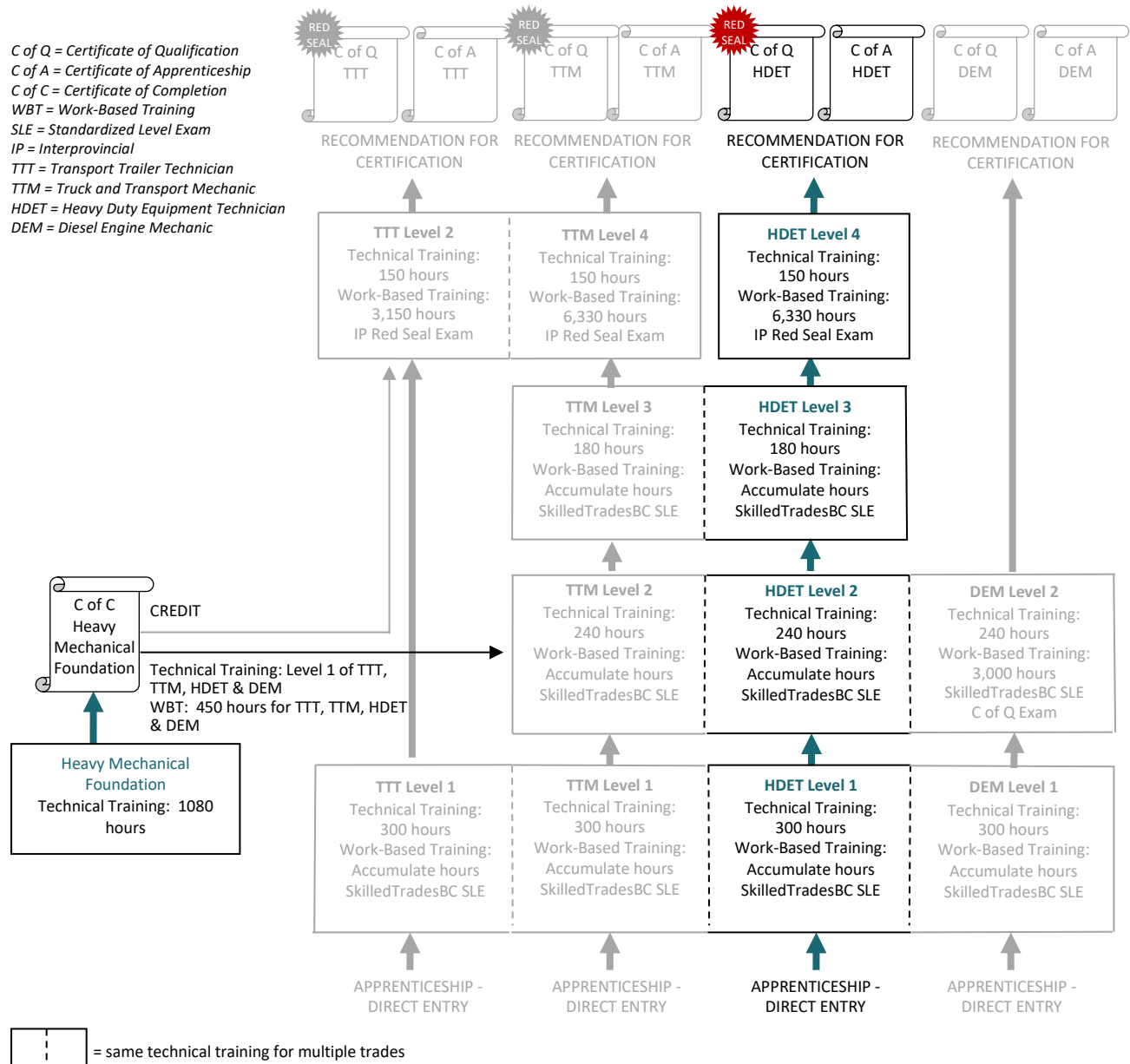
Section 2

PROGRAM OVERVIEW

Heavy Duty Equipment Technician

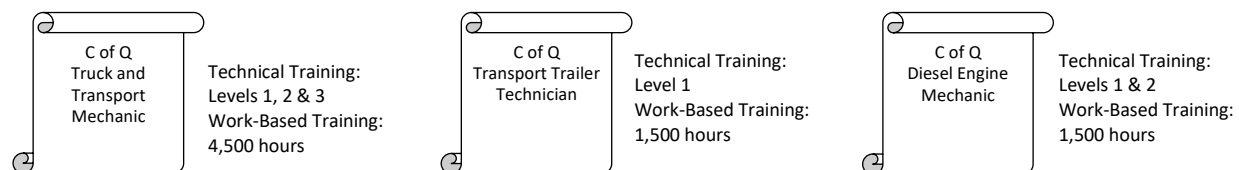
Program Credentialing Model

This graphic provides an overview of the Heavy Duty Equipment Technician 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

HEAVY DUTY EQUIPMENT TECHNICIAN

Occupation Description: “Heavy Duty Equipment Technician” means a person who maintains, manufactures, overhauls, reconditions and repairs equipment powered by internal combustion engines or electricity and without limiting the foregoing, including graders, loaders, shovels, and articulated trucks, haul trucks, forklifts, wheeled and tracked vehicles of all types used in construction, logging, sawmill, manufacturing, mining, and other similar industry.

F = Foundation

2-TTT = Level 2 for Transport Trailer Technician only

4-HDET = Level 4 for Heavy Duty Equipment Technician only

4-TTM = Level 4 for Truck and Transport Mechanic only

4 = Level 4 for both Truck and Transport Mechanic and Heavy Duty Equipment Technician

 = Competency appears only in Truck and Transport Mechanic and Transport Trailer Technician

 = Competency appears only in Heavy Duty Equipment Technician

Grey text = Competency does not appear in this Heavy Mechanical trade

PERFORM OCCUPATIONAL SKILLS A	Use safe work practices <div style="text-align: right;">A1</div>	Implement hybrid and electric vehicle (EV) safety protocols <div style="text-align: right;">A2</div>	Use hand tools, power tools, and shop equipment <div style="text-align: right;">A3</div>	Use fasteners and fittings <div style="text-align: right;">A4</div>	Lift and support loads <div style="text-align: right;">A5</div>	Operate equipment <div style="text-align: right;">A6</div>
	1 F	1 F	1 F	1 F	1 F	1 F
	Use documentation and reference materials <div style="text-align: right;">A7</div>	Service bearings and seals <div style="text-align: right;">A8</div>	Select and maintain lubricants <div style="text-align: right;">A9</div>	Use cutting and welding equipment <div style="text-align: right;">A10</div>	Describe diagnostic procedures <div style="text-align: right;">A11</div>	
	1 F	1 F	1 F	1 F	1 F	
SERVICE, DIAGNOSE, AND REPAIR BRAKES B	Service and repair hydraulic brakes and parking brakes <div style="text-align: right;">B1</div>	Service and repair hydraulic power brakes and ABS systems <div style="text-align: right;">B2</div>	Service and repair air brakes <div style="text-align: right;">B3</div>	Diagnose and repair advanced brake systems <div style="text-align: right;">B4</div>		
	1 F	1 F	1 F	2-TTT	4-TTM	

Section 2 Program Overview

SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS C	Service hydraulic components C1 1 F	Diagnose and repair advanced hydraulic systems C2 2-TTT 4			
SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS D	Describe electricity D1 1 F	Use electrical testing instruments D2 1 F	Service, diagnose, and repair battery systems D3 1 F	Service starting and charging systems D4 1 F	Service electrical circuits D5 1 F
					Diagnose and repair charging systems D6 2
	Diagnose and repair starting systems D7 2	Diagnose and repair electrical and electronic components and systems D8 2	Diagnose and repair vehicle and equipment management systems D9 2	Service, diagnose, and repair electronic ignition systems D10 2	
SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION E	Service, diagnose, and repair tires, wheels, and hubs E1 1 F	Service steering systems E2 1 F	Service, diagnose, and repair suspension systems E3 1 F	Service undercarriage systems E4 1	Service, diagnose, and repair frames E5 1 F
					Diagnose and repair wheeled equipment steering E6 4-HDET
	Diagnose and repair track machine steering E7 4-HDET	Diagnose and repair undercarriage E8 4-HDET	Diagnose and repair truck steering systems E9 2-TTT 4-TTM	Align truck and trailer E10 2-TTT 4-TTM	
SERVICE, DIAGNOSE, AND REPAIR TRAILERS F	Service, diagnose, and repair landing gear and trailer accessories F1 1 F	Service, diagnose, and repair coupling systems F2 1 F	Service, diagnose, and repair trailer body components F3 1 F	Service heating and refrigeration systems F4 1 F	Diagnose and repair heating and refrigeration systems F5 2-TTT 4-TTM

Section 2 Program Overview

**SERVICE, DIAGNOSE,
AND REPAIR HEATING,
VENTILATION, AND AIR
CONDITIONING**
G

Describe heating and air conditioning fundamentals

G1

1				F
---	--	--	--	---

Service, diagnose, and repair heating and air conditioning systems

G2

	2-TTT		4	
--	-------	--	---	--

**SERVICE, DIAGNOSE,
AND REPAIR ENGINES
AND SUPPORTING
SYSTEMS**
H

Describe engine fundamentals

H1

	2			
--	---	--	--	--

Service engine support systems

H2

	2			F
--	---	--	--	---

Diagnose and repair engine support systems

H3

	2			
--	---	--	--	--

Service diesel fuel supply systems

H4

	2			F
--	---	--	--	---

Diagnose and repair diesel fuel supply systems

H5

	2			
--	---	--	--	--

Describe alternative fuel systems

H6

	2			
--	---	--	--	--

Service, diagnose, and repair engines and components

H7

	2			
--	---	--	--	--

Diagnose and repair mechanical fuel injection systems

H8

	2			
--	---	--	--	--

Service, diagnose, and repair electronic diesel fuel systems

H9

	2			
--	---	--	--	--

Service, diagnose, and repair diesel emissions systems

H10

	2			
--	---	--	--	--

Service, diagnose, and repair engine retarder systems

H11

	2			
--	---	--	--	--

**SERVICE, DIAGNOSE,
AND REPAIR
POWERTRAINS**
I

Describe power transfer systems

I1

		3		
--	--	---	--	--

Service, diagnose, and repair clutches

I2

		3		
--	--	---	--	--

Service, diagnose, and repair manual transmissions

I3

		3		
--	--	---	--	--

Service, diagnose, and repair automated transmissions

I4

		3		
--	--	---	--	--

Service, diagnose, and repair automatic transmissions and torque converters

I5

		3		
--	--	---	--	--

Service, diagnose, and repair power shift transmissions

I6

		3		
--	--	---	--	--

Service, diagnose, and repair drivelines

I7

		3		
--	--	---	--	--

Service, diagnose, and repair drive axles

I8

		3		
--	--	---	--	--

Service, diagnose, and repair final drives

I9

		3		
--	--	---	--	--

Service, diagnose, and repair drivetrain retarders

I10

		3		
--	--	---	--	--

Service, diagnose, and repair winches

I11

		3		
--	--	---	--	--

Service, diagnose, and repair power take-offs and transfer cases

I12

		3		
--	--	---	--	--

**Section 2
Program Overview**

SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES J	Describe protective structures J1	Service, diagnose, and repair cab structures J2	Service, diagnose, and repair sound suppression systems J3	Diagnose and repair attachments and accessories J4	Diagnose and repair pneumatic systems J5
	1	1	4-HDET	4-HDET	4-HDET
SERVICE, DIAGNOSE, AND REPAIR HYBRID AND ELECTRIC VEHICLES (EV) K	Service, diagnose, and repair hybrid vehicles and hybrid equipment K1	Service, diagnose, and repair electric vehicles (EV) K2			
	2-TTT	2-TTT	4		
USE COMMUNICATION AND MENTORING TECHNIQUES L	Use communication techniques L1	Use mentoring techniques L2			
	1	2-TTT	4		

Training Topics and Suggested Time Allocation

HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 1

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line A	PERFORM OCCUPATIONAL SKILLS	18%	55%	45%	100%
A1	Use safe work practices		✓	✓	
A2	Implement hybrid and electric vehicle (EV) safety protocols		✓	✓	
A3	Use hand tools, power tools, and shop equipment		✓	✓	
A4	Use fasteners and fittings		✓	✓	
A5	Lift and support loads		✓	✓	
A6	Operate equipment		✓	✓	
A7	Use documentation and reference materials		✓	✓	
A8	Service bearings and seals		✓	✓	
A9	Select and maintain lubricants		✓	✓	
A10	Use cutting and welding equipment		✓	✓	
A11	Describe diagnostic procedures		✓		
Line B	SERVICE, DIAGNOSE, AND REPAIR BRAKES	17%	40%	60%	100%
B1	Service and repair hydraulic brakes and parking brakes		✓	✓	
B2	Service and repair hydraulic power brakes and ABS systems		✓	✓	
B3	Service and repair air brakes		✓	✓	
Line C	SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS	14%	60%	40%	100%
C1	Service hydraulic components		✓	✓	
Line D	SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS	19%	55%	45%	100%
D1	Describe electricity		✓		
D2	Use electrical testing instruments		✓	✓	
D3	Service, diagnose, and repair battery systems		✓	✓	
D4	Service starting and charging systems		✓	✓	
D5	Service electrical circuits		✓	✓	
Line E	SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION	15%	50%	50%	100%
E1	Service, diagnose, and repair tires, wheels, and hubs		✓	✓	
E2	Service steering systems		✓	✓	
E3	Service, diagnose, and repair suspension systems		✓	✓	
E4	Service undercarriage systems		✓	✓	
E5	Service, diagnose, and repair frames		✓	✓	
Line F	SERVICE, DIAGNOSE, AND REPAIR TRAILERS	8%	35%	65%	100%
F1	Service, diagnose, and repair landing gear and trailer accessories		✓	✓	
F2	Service, diagnose, and repair coupling systems		✓	✓	
F3	Service, diagnose, and repair trailer body components		✓	✓	

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
F4	Service heating and refrigeration systems		✓	✓	
Line G	SERVICE, DIAGNOSE, AND REPAIR HEATING, VENTILATION, AND AIR CONDITIONING	4%	100%	0%	100%
G1	Describe heating and air conditioning fundamentals		✓		
Line J	SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES	4%	60%	40%	100%
J1	Describe protective structures		✓		
J2	Service, diagnose, and repair cab structures		✓	✓	
Line L	USE COMMUNICATION AND MENTORING TECHNIQUES	1%	50%	50%	100%
L1	Use communication techniques		✓	✓	
Total Percentage for Heavy Duty Equipment Technician Level 1		100%			

Training Topics and Suggested Time Allocation

HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 2

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line D	SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS	25%	40%	60%	100%
D6	Diagnose and repair charging systems		✓	✓	
D7	Diagnose and repair starting systems		✓	✓	
D8	Diagnose and repair electrical and electronic components and systems		✓	✓	
D9	Diagnose and repair vehicle and equipment management systems		✓	✓	
D10	Service, diagnose, and repair electronic ignition systems		✓	✓	
Line H	SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS	75%	50%	50%	100%
H1	Describe engine fundamentals		✓		
H2	Service engine support systems		✓	✓	
H3	Diagnose and repair engine support systems		✓	✓	
H4	Service diesel fuel supply systems		✓	✓	
H5	Diagnose and repair diesel fuel supply systems		✓	✓	
H6	Describe alternative fuel systems		✓		
H7	Service, diagnose, and repair engines and components		✓	✓	
H8	Diagnose and repair mechanical fuel injection systems		✓	✓	
H9	Service, diagnose, and repair electronic diesel fuel systems		✓	✓	
H10	Service, diagnose, and repair diesel emissions systems		✓	✓	
H11	Service, diagnose, and repair engine retarder systems		✓	✓	
Total Percentage for Heavy Duty Equipment Technician Level 2		100%			

Training Topics and Suggested Time Allocation

HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 3

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS	100%	50%	50%	100%
I1	Describe power transfer systems		✓		
I2	Service, diagnose, and repair clutches		✓	✓	
I3	Service, diagnose, and repair manual transmissions		✓	✓	
I4	Service, diagnose, and repair automated transmissions		✓	✓	
I5	Service, diagnose, and repair automatic transmissions and torque converters		✓	✓	
I6	Service, diagnose, and repair power shift transmissions		✓	✓	
I7	Service, diagnose, and repair drivelines		✓	✓	
I8	Service, diagnose, and repair drive axles		✓	✓	
I9	Service, diagnose, and repair final drives		✓	✓	
I10	Service, diagnose, and repair drivetrain retarders		✓	✓	
I11	Service, diagnose, and repair winches		✓	✓	
I12	Service, diagnose, and repair power take-offs and transfer cases		✓	✓	
Total Percentage for Heavy Duty Equipment Technician Level 3		100%			

Training Topics and Suggested Time Allocation

HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 4

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line C	SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS	53%	45%	55%	100%
C2	Diagnose and repair advanced hydraulic systems		✓	✓	
Line E	SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION	15%	50%	50%	100%
E6	Diagnose and repair wheeled equipment steering		✓	✓	
E7	Diagnose and repair track machine steering		✓	✓	
E8	Diagnose and repair undercarriage		✓	✓	
Line G	SERVICE, DIAGNOSE, AND REPAIR HEATING, VENTILATION, AND AIR CONDITIONING	10%	50%	50%	100%
G2	Service, diagnose, and repair heating and air conditioning systems		✓	✓	
Line J	SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES	9%	55%	45%	100%
J3	Service, diagnose, and repair sound suppression systems		✓	✓	
J4	Diagnose and repair attachments and accessories		✓	✓	
J5	Diagnose and repair pneumatic systems		✓	✓	
Line K	SERVICE, DIAGNOSE, AND REPAIR HYBRID AND ELECTRIC VEHICLES (EV)	10%	60%	40%	100%
K1	Service, diagnose, and repair hybrid vehicles and hybrid equipment		✓	✓	
K2	Service, diagnose, and repair electric vehicles (EV)		✓	✓	
Line L	USE COMMUNICATION AND MENTORING TECHNIQUES	3%	100%	0%	100%
L2	Use mentoring techniques		✓		
Total Percentage for Heavy Duty Equipment Technician Level 4		100%			

Section 3

PROGRAM CONTENT

Heavy Duty Equipment Technician

Level 1

Heavy Duty Equipment Technician

Line (GAC): A **PERFORM OCCUPATIONAL SKILLS**

Competency: **A1 Use safe work practices**

Objectives

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

- Apply personal safety measures
- Demonstrate knowledge of jurisdictional safety certifications and requirements
- Perform risk assessment
- Identify and use shop emergency equipment
- Prevent, identify and extinguish various classes of fires

LEARNING TASKS

1. Apply personal safety precautions and procedures

CONTENT

- Personal apparel
 - Clothing
 - Hair and beards
 - Jewellery
- Personal protective equipment (PPE)
 - Maintenaning PPE
- Safety meetings
- Housekeeping
- Ventilation systems
- Respect for others' safety
- Situational awareness
- Ergonomics

2. Perform applicable lock out procedures

- WorkSafeBC requirements
- Electrical isolation (Night switch)
- Tag
- Key storage
- Equipment and machine lock-out

3. Demonstrate knowledge of jurisdictional safety certifications and requirements

- Compressed gas certifications
- Refrigerant handler certificate
- WorkSafeBC requirements
- Commercial Vehicle Safety Enforcement regulations (CVSE)
- Environmental regulations

- #### 4. Perform risk assessment

- Workplace hazards
- Job task hazards
- Environmental hazards

LEARNING TASKS

CONTENT

- | | |
|--|--|
| | <ul style="list-style-type: none"> • Hazard documentation and reporting |
| 5. Locate shop emergency equipment and procedures | <ul style="list-style-type: none"> • Site safety plan <ul style="list-style-type: none"> ○ Emergency shutoffs ○ Fire control systems ○ Eye wash facilities ○ Emergency exits ○ First aid facilities ○ Emergency contact/phone numbers ○ Muster points |
| 6. Describe fire safety | <ul style="list-style-type: none"> • Conditions necessary to support a fire • Classes of fires • Symbols and colours |
| 7. Apply preventative fire safety precautions when working near, handling or storing flammable liquids or gases, combustible materials, and electrical apparatus | <ul style="list-style-type: none"> • Liquid and compressed fuels • Ventilation • Purging • Lubricants • Combustible materials • Aerosols |
| 8. Describe the considerations taken to fight a fire | <ul style="list-style-type: none"> • Warning others and the Fire Department • Evacuation of others • Fire containment • Escape route • Training • Describe the procedure for using a fire extinguisher <ul style="list-style-type: none"> ○ P.A.S.S. |
| 9. Describe equipment fire suppression systems | <ul style="list-style-type: none"> • Types • Construction • Operation • Disarming |

Line (GAC):	A	PERFORM OCCUPATIONAL SKILLS
Competency:	A2	Implement hybrid and electric vehicle (EV) safety protocols

Objectives

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

- Identify hybrid and electric vehicle (EV) safety hazards
- Select and use high voltage PPE, tools, and equipment
- Implement and follow hybrid and EV safety protocols

LEARNING TASKS

CONTENT

1. Identify hybrid and electric vehicle (EV) safety hazards	<ul style="list-style-type: none"> • Arc flash • Electrocutation • Burns • High voltage sources • Stored energy • Environmental conditions
2. Select and use high voltage PPE	<ul style="list-style-type: none"> • Arc flash suits • Insulated gloves • Non-conductive boots • High voltage signage • Insulated safety rescue hook • Lock-out and tag-out devices
3. Select and use high voltage tools and equipment	<ul style="list-style-type: none"> • Insulated high voltage tools • Specialized lifting equipment • Specizlied testing equipment
4. Implement and follow hybrid and EV safety protocols	<ul style="list-style-type: none"> • High voltage work procedures • Manufacturer procedures • Facility requirements • Knowledge of jurisdictional hybrid / EV safety certifications and requirements

Line (GAC):	A	PERFORM OCCUPATIONAL SKILLS
Competency:	A3	Use hand tools, power tools, and shop equipment

Objectives

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

- Select, use, and maintain tools and shop equipment
- Select, use, and maintain safety equipment

LEARNING TASKS
CONTENT

- | | |
|---|---|
| 1. Use protective equipment associated with the use of tools and shop equipment | <ul style="list-style-type: none"> • PPE • Screening • Guarding • Ventilation • Clean up |
| 2. Apply lock-out procedures to shop equipment | <ul style="list-style-type: none"> • WorkSafeBC lock-out procedures • Electrical isolation • Tags • Locks |
| 3. Select, use, and maintain hand tools | <ul style="list-style-type: none"> • Hand tool safety <ul style="list-style-type: none"> ○ Safety practices ○ Hazards ○ Organizing work area ○ Maintaining hand tools ○ Safe tool handling and storage • Hand tool selection <ul style="list-style-type: none"> ○ Fastener tools ○ Cutting tools ○ Clamping tools ○ Pullers ○ Multipliers • Grease gun |
| 4. Select, use, and maintain measuring instruments | <ul style="list-style-type: none"> • Layout tools • Imperial and metric precision measuring and calibration • Micrometer • Veriner • Bore gauges • Dial indicator |

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>5. Select, use, and maintain power tools</p> <p>6. Select, use, and maintain drill bits</p> <p>7. Select, use, and maintain shop equipment</p> | <ul style="list-style-type: none"> • Feeler/thickness gauges • Torque wrenches
 • Pneumatic <ul style="list-style-type: none"> ○ Lubrication • Electric <ul style="list-style-type: none"> ○ Corded ○ Cordless • Hydraulic
 • Types • Sharpening • Cutting speeds • Lubricants
 • Presses • Parts cleaning equipment <ul style="list-style-type: none"> ○ Hot tank ○ Cold solution ○ Hot agitator ○ Solvent tank ○ Pressure washer ○ Steam cleaner ○ Chemical cleaners • Drill press • Glass beader • Sand blaster • Grinders • Compressor • Cut-off saws |
|---|--|

Achievement Criteria

Performance	The learner will be able to use hand tools, power tools, and shop equipment.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Hand tools, power tools, and shop equipment • Test equipment • Manufacturer's Specifications • A work place or training environment
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p>

Line (GAC): **A PERFORM OCCUPATIONAL SKILLS**
Competency: **A4 Use fasteners and fittings**

Objectives

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

- Select and use imperial and metric fasteners
- Select and use pipe, tubing, hose, and fittings

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Select and use imperial and metric fasteners | <ul style="list-style-type: none"> • Thread systems • Fastener types <ul style="list-style-type: none"> ○ Installation • Washers <ul style="list-style-type: none"> ○ Types ○ Applications • Locking devices <ul style="list-style-type: none"> ○ Types ○ Applications |
| 2. Cut and repair internal and external threads | <ul style="list-style-type: none"> • Taps • Dies • Thread repair • Broken fastener extraction |
| 3. Select, use, and repair tubing, pipe and fittings | <ul style="list-style-type: none"> • Tubing <ul style="list-style-type: none"> ○ Types ○ Sizing ○ Applications • Pipe <ul style="list-style-type: none"> ○ Types ○ Sizing • Threads <ul style="list-style-type: none"> ○ Applications • Fitting <ul style="list-style-type: none"> ○ Types ○ Sizing ○ Applications • Assembly procedures • Sealants • Cutting, bending, and flaring |

LEARNING TASKS

4. Select and use hose and hose fittings

CONTENT

- Hose
 - Types
 - Sizing
 - Applications
- Assembly
- Hose fittings
 - Types

Line (GAC):	A	PERFORM OCCUPATIONAL SKILLS
Competency:	A5	Lift and support loads

Objectives

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

- Apply the WorkSafeBC Safety Regulations to lifting and blocking applications
- Select, use, and maintain lifting and blocking equipment
- Select, use, and maintain staging and access equipment
- Inspect and service wire rope
- Lift and move loads

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Apply the Occupational Health and Safety Regulations | <ul style="list-style-type: none"> • Refer to regulations <ul style="list-style-type: none"> ○ PPE ○ Clothing ○ Housekeeping ○ Safe lifting and carrying ○ Safe handling with cranes ○ Maintenance and service documentation |
| 2. Determine load weight | <ul style="list-style-type: none"> • Manufacturer's specification • Estimation |
| 3. Select, use, and maintain jacks | <ul style="list-style-type: none"> • Types • Capacities |
| 4. Select, use, and maintain stands and blocking | <ul style="list-style-type: none"> • Manufacturer's procedures • Types • Capacities • Bridging |
| 5. Select, use, and maintain staging and access equipment | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Aerial work platforms ○ Scissor lifts ○ Scaffolding ○ Mobile steps and ladders ○ Fall arrest systems • Capacities |

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 6. Select, use, and maintain wire slings, chains and lifting straps | <ul style="list-style-type: none"> • Types • Capacities • Rating tags • Rigging and lifting attachments |
| 7. Select, use, and maintain wire rope | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Regular lay ○ Lang lay • Construction • Application • Safe working load • Inspection frequency • Damage and wear • Removal • Repair/replacement • Lubrication • Scheduled maintenance |
| 8. Use visual and sound signals | <ul style="list-style-type: none"> • WorkSafeBC Safety Regulations <ul style="list-style-type: none"> ○ Hand ○ Sound |
| 9. Select, use, and maintain hoisting equipment | <ul style="list-style-type: none"> • Types • Capacities • Operation |
| 10. Lift, hoist, and move loads | <ul style="list-style-type: none"> • Determine safe working load • Lifting and rigging procedures • Jurisdictional regulations and certifications |

Line (GAC): **A PERFORM OCCUPATIONAL SKILLS**
Competency: **A6 Operate equipment**

Objectives

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

- Perform pre-start and walk around inspections
- Start, move, secure, and stop equipment

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Describe pre-start and walk around inspections | <ul style="list-style-type: none"> • Checklist • Operator's manuals |
| 2. Describe starting aids | <ul style="list-style-type: none"> • Glow plug systems • Intake preheater systems • Starting fluids • Block/circulating heaters • Battery warmers |
| 3. Describe start up procedures | <ul style="list-style-type: none"> • Controls • Cranking • Monitoring • Jump starting |
| 4. Describe emergency shut down procedures | <ul style="list-style-type: none"> • Cut-off <ul style="list-style-type: none"> ○ Fuel ○ Air |
| 5. Start, operate, and shut down selected equipment | <ul style="list-style-type: none"> • Pre-start and walk around • Use of starting aids • Moving • Securing and shutting down • Electrical isolation (Night switch) |

Line (GAC): **A PERFORM OCCUPATIONAL SKILLS**
Competency: **A7 Use documentation and reference materials**

Objectives

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

- Communicate using forms and reports
- Use computers and written media to locate service and maintenance information

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Use documentation forms</p> | <ul style="list-style-type: none"> • Business forms <ul style="list-style-type: none"> ○ Work order ○ Parts requisition ○ Purchase order • Record keeping forms <ul style="list-style-type: none"> ○ Time sheets and daily time card ○ Equipment log ○ Maintenance log ○ Personal log ○ Maintenance schedule ○ Warranty • Confidentiality guidelines |
| <p>2. Describe the requirements for report writing</p> | <ul style="list-style-type: none"> • Types of reports <ul style="list-style-type: none"> ○ Service ○ Structure ○ Attachments ○ Shift end ○ Maintenance log ○ Accident ○ Safety ○ Digital media |
| <p>3. Use manuals</p> | <ul style="list-style-type: none"> • Technical <ul style="list-style-type: none"> ○ Service ○ Repair • Parts • Systems • Operators • Service bulletins/updates • Digital media |

Line (GAC): **A PERFORM OCCUPATIONAL SKILLS**
Competency: **A8 Service bearings and seals**

Objectives

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

- Select bearing and seals
- Service bearings and seals

LEARNING TASKS

1. Describe bearings

CONTENT

- Purpose
- Types
 - Friction
 - Antifriction
- Terminology
- Applications
- Loads
 - Axial
 - Radial

2. Select and service bearings

- Removal
- Clean
- Inspection
 - Pitting
 - Scoring
 - Brinelling
- Lubrication
- Storage
- Installation
 - Heating
 - Cooling
- Adjustments

3. Describe seals and sealants

- Types
 - Static
 - Dynamic
- Applications

4. Select and service seals and sealants

- Removal
- Inspection
- Fabrication
- Installation

Line (GAC): A **PERFORM OCCUPATIONAL SKILLS**

Competency: **A9 Select and maintain lubricants**

Objectives

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

- Describe lubricants
- Identify lubricants
- Select lubricants
- Perform fluid analysis

LEARNING TASKS

1. Describe the theory of lubrication
2. Describe the properties of lubricants

CONTENT

- Friction
- Purpose
- Viscosity
- Viscosity Index
- Additives
- Types
 - Oils
 - Greases
 - Dry lubricants
 - Synthetics
 - Environmentally Friendly Liquids
- Ratings
 - American Petroleum Institute (API)
 - Society of Automotive Engineers (SAE)
 - International Organization for Standardization (ISO)
 - Military Standards
 - International Lubricant Standardization Approval Committee
- Applications
- Oils
- Greases
- Dry lubricants
- Synthetics
- Manufacturer's specifications
- Minimum requirements
- Warranty issues

3. Describe the use of lubricants

LEARNING TASKS

CONTENT

4. Handle and maintain lubricants

- Storage
- Disposal
- Personal protection

5. Perform fluid analysis

- Procedures
- Safety
- Reports
 - Interpretation of test results
 - Contamination
 - Condition
 - Recommendations

Line (GAC): A PERFORM OCCUPATIONAL SKILLS

Competency: **A10 Use cutting and welding equipment**

Objectives

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

- Identify metals
- Describe different welding procedures
- Cut, weld, and braze using oxy-acetylene
- Perform shielded metal arc weld
- Weld using wire feed processes
- Solder tubing and sheet metal

LEARNING TASKS

CONTENT

- | | | |
|----|--|--|
| 1. | Identify regulations with respect to welding | <ul style="list-style-type: none">• WorkSafeBC Safety Regulations• Transportation of Dangerous Goods Act (TDG)• Required certifications |
| 2. | Identify metals | <ul style="list-style-type: none">• Metals<ul style="list-style-type: none">○ Steel○ Aluminum |
| 3. | Identify oxy-acetylene components | <ul style="list-style-type: none">• Safety precautions• Gases• Valves and regulators• Cylinders• Hoses and fittings• Cutting torches and tips• Flashback valves• Check valves |
| 4. | Use oxy-acetylene equipment | <ul style="list-style-type: none">• Assembly procedures• Operation procedures• Lighting• Pressures• Adjusting• Shut down procedures• Leak testing• Storage |

LEARNING TASKS
CONTENT

- | | |
|---|---|
| 5. Cut mild steel with oxy-acetylene equipment | <ul style="list-style-type: none"> • Set-up • Freehand cuts • Guided cuts • Hole piercing |
| 6. Braze with oxy-acetylene equipment | <ul style="list-style-type: none"> • Brazing set-up • Brazing techniques |
| 7. Describe the shielded metal arc welding (SMAW) process | <ul style="list-style-type: none"> • Process • Applications <ul style="list-style-type: none"> ○ Safety requirements |
| 8. Identify shielded metal arc welding equipment | <ul style="list-style-type: none"> • AC/DC machines • Components • Electrodes <ul style="list-style-type: none"> ○ Classifications ○ Selection ○ Storage and handling • Electrode holder • Ground clamps • Cables • Connectors |
| 9. Weld mild steel with shielded metal arc | <ul style="list-style-type: none"> • Procedures • Weld ground placement • Settings • Positions • Joints • Types of welds |
| 10. Weld mild steel using wire feed processes | <ul style="list-style-type: none"> • Procedures • Settings • Safety • Weld types and positions • Wire type |
| 11. Select and use air-arc and plasma cutting equipment | <ul style="list-style-type: none"> • Purpose • Procedure • Safety • Maintain |

Achievement Criteria

Performance	The learner will be able to use cutting and welding equipment.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer’s Specifications • A work place or training environment • Cutting and welding equipment
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer’s specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **A PERFORM OCCUPATIONAL SKILLS**
Competency: **A11 Describe diagnostic procedures**

Objectives

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

- Describe the importance of following a diagnostic procedure
- Describe diagnostic procedures used for troubleshooting

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Describe the importance of following a diagnostic process | <ul style="list-style-type: none"> • Cost of improper diagnosis • Unhappy customers • Lost business • Damage to components • Time management • Efficiency |
| 2. Describe general diagnostic procedures | <ul style="list-style-type: none"> • Understanding system • Understanding complaint • Communicating with operator • Operational test • Visual inspection • Forming all possible conclusions • Test conclusions • System component isolation |
| 3. Describe the importance of following manufacturer's diagnostic procedures where available | <ul style="list-style-type: none"> • Warranty requirement • Warranty claims • Diagnostic efficiency |
| 4. Describe the importance of failure analysis | <ul style="list-style-type: none"> • Repeat failure • Extend life • Cost • Customer satisfaction |

Line (GAC):	B	SERVICE, DIAGNOSE, AND REPAIR BRAKES
Competency:	B1	Service and repair hydraulic brakes and parking brakes

Objectives

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

- Service hydraulic brake systems
- Diagnose hydraulic brake systems
- Repair hydraulic brake systems

LEARNING TASKS

1. Describe the principles of braking

2. Describe the foundation brake

3. Review hydraulic principles

4. Describe the hydraulics of a brake system

CONTENT

- Coefficient of friction
- Heat
 - Absorption
 - Dissipation
- Effects of speed and weight
- Brake fade

- Types
 - Disk
 - Drum
 - Multidisc
- Components
 - Calipers
 - Wheel cylinder
 - Lines
 - Shoes/pads
- Operation
 - Self energizing and non-self energizing
 - Servo/non-servo

- Pressure
- Force
- Area

- Types
 - Disk
 - Drum
 - Multidisc
- Components
 - Master cylinder
 - Metering valve

LEARNING TASKS

CONTENT

5. Select and maintain brake fluids

- Proportioning valve
- Switches
- Operation

6. Describe parking brake systems

- Requirements
- Types
 - DOT 3
 - DOT 4
 - DOT 5
- Characteristics
 - Hygroscopic
 - Boiling point
 - Viscosity
- Identification

7. Diagnose hydraulic brake systems

- Types
 - Integral
 - Driveline
 - Hydraulic
 - Mechanical
- Components
- Operation
- Measurements
- Diagnostic procedures
 - Operational checks
 - Fluid condition/level
- Inspection
- Failure analysis

8. Repair hydraulic brake systems

- Components
 - Hydraulic
 - Mechanical
- Inspection
- Removal
- Repair/replacement
- Installation
- Flushing/bleeding

9. Service parking brake systems

- Inspection
- Removal

LEARNING TASKS

CONTENT

- | | |
|------------------------------------|--|
| 10. Perform preventive maintenance | <ul style="list-style-type: none"> • Repair/replacement • Installation |
| | <ul style="list-style-type: none"> • Inspection • Operational tests • Fluid level checks • Adjustment • Lubrication |

Achievement Criteria

- | | |
|-------------|---|
| Performance | The learner will be able to service and repair hydraulic brakes and parking brakes. |
| Conditions | <p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with hydraulic brakes with park brakes |
| Criteria | <p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC):	B	SERVICE, DIAGNOSE, AND REPAIR BRAKES
Competency:	B2	Service and repair hydraulic power brakes and ABS systems

Objectives

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

- Diagnose hydraulic assisted power brake systems
- Repair hydraulic assisted power brake systems
- Describe hydraulic anti-lock braking (ABS) systems
- Diagnose hydraulic anti-lock braking (ABS) systems
- Repair hydraulic anti-lock braking (ABS) systems

LEARNING TASKS

1. Describe power brake systems

2. Diagnose power brake systems

3. Repair power brake systems

4. Describe hydraulic anti-lock braking systems

CONTENT

- Types
 - Vacuum boosters
 - Hydro-boost
 - Hydro-max
 - Hydraulic
- Components
- Operation

- Sensory inspection
- Testing
 - Operational
- Failure analysis

- Inspection
- Removal
- Repair/replacement/rebuild
- Installation
- Bleeding
- Adjustments and calibrations
- Verification of system operation

- Types
 - Single channel
 - Multi channel
- Components
- Operation
- Precautions

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 5. Diagnose hydraulic anti-lock braking systems | <ul style="list-style-type: none"> • Manufacturer's diagnostic procedures • Road test • Diagnostic codes • Components • Inspection • Testing |
| 6. Repair hydraulic anti-lock braking systems | <ul style="list-style-type: none"> • Inspection • Removal • Repair/replacement/rebuild • Installation • Bleeding • Adjustments and calibrations • Verification of system operation • Diagnostic codes |

Achievement Criteria

- | | |
|-------------|---|
| Performance | The learner will be able to service and repair hydraulic power brakes and ABS systems. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with hydraulic ABS and power brakes |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	B	SERVICE, DIAGNOSE, AND REPAIR BRAKES
Competency:	B3	Service and repair air brakes

Objectives

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

- Describe the principles of braking
- Describe the principles of pneumatics
- Describe air brake schedules and components
- Service air brake systems
- Repair a wheel brake assembly

LEARNING TASKS

1. Describe the principles of braking

2. Describe the principles of pneumatics

3. Describe a basic air brake system

4. Describe air over hydraulic braking systems

CONTENT

- Coefficient of friction
- Heat
 - Absorption
 - Dissipation
- Effects of speed and weight
- Brake fade
- Characteristics of air
- Relationship between force, pressure and area
- Effects of heat on air
- Time lag
- Pneumatic balance
- Sub systems
 - Supply
 - Delivery
- Foundation brakes
 - Drum
 - Disc
- Components
 - Compressor
 - Governor
 - Treadle
 - Relay
 - Brake chamber
- Operation
- Components

LEARNING TASKS

CONTENT

- | | |
|---|--|
| | <ul style="list-style-type: none"> • Operation |
| 5. Describe the basics of air brake schedules | <ul style="list-style-type: none"> • 121 • X • SX • Operation and routine maintenance |
| 6. Repair foundation brake assembly | <ul style="list-style-type: none"> • Inspection • Disassembly • Replacement • Measurement • Assembly • Adjustment |
| 7. Service and inspect air brakes | <ul style="list-style-type: none"> • Tractor and trailer • Caging brakes • Components <ul style="list-style-type: none"> ○ Foundation brakes ○ Reservoirs ○ Lines ○ Disc/Drum ○ Valves • Adjustment • Scheduled maintenance |

Achievement Criteria

- | | |
|-------------|---|
| Performance | The learner will be able to service and repair air brakes. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with air disc and drum brakes |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task to manufacturer's specifications • Conducted task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	C	SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS
Competency:	C1	Service hydraulic components

Objectives

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

- Describe the principles of hydraulics
- Describe the basic components of a hydraulic system
- Describe the types of hydraulic systems
- Identify hydraulic components
- Select hydraulic fluids for applications
- Select and assemble hydraulic hoses and fittings
- Demonstrate safe work procedures for hydraulic systems service
- Perform scheduled maintenance on hydraulic systems

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Describe the principles of hydraulics | <ul style="list-style-type: none"> • Terminology • Advantages/disadvantages • Fluid characteristics • Pascal's Law • Calculations • Bernoulli's Principle |
| 2. Perform calculations | <ul style="list-style-type: none"> • Area • Volume • Force • Pressure • Flow rate • Pascal's law |
| 3. Describe the basic operation of a hydraulic system and components | <ul style="list-style-type: none"> • Filters • Accumulators • Seals • Fittings • Reservoir <ul style="list-style-type: none"> ○ Vented ○ Pressurized • Pump <ul style="list-style-type: none"> ○ Positive displacement <ul style="list-style-type: none"> ▪ Gear ▪ Vane |

LEARNING TASKS

CONTENT

	<ul style="list-style-type: none"> ▪ Piston ○ Ratings <ul style="list-style-type: none"> ▪ Pressure ▪ Flow • Control valves <ul style="list-style-type: none"> ○ Pressure ○ Directional ○ Volume • Actuators <ul style="list-style-type: none"> ○ Cylinder ○ Motor • Connecting lines • Hydraulic fluids
4. Describe types of hydraulic systems	<ul style="list-style-type: none"> • Open-centre • Closed-centre • Self-contained • Auxillary-powered
5. Demonstrate safe work procedures	<ul style="list-style-type: none"> • Safety blocking equipment and attachments • Relieve pressure • Reservoir venting • Actuator neutralization • Temperature hazards
6. Service hydraulic systems	<ul style="list-style-type: none"> • Visual inspection • Leaks • Hose rubs • External damage • Fluid level check • Filter change, fluid change, and fluid analysis • Strainers • Flushing system
7. Interpret basic hydraulic diagrams	<ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Pictorial ○ Schematic • Basic symbols

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 8. Select hydraulic fluids | <ul style="list-style-type: none"> • Requirements • SAE viscosity ratings • ISO viscosity ratings • API service ratings • Manufacturer's specifications • Synthetic/Non-synthetic • Component/System compatibility • Eco-friendly |
| 9. Select hydraulic hoses and fittings | <ul style="list-style-type: none"> • Hose construction • Ratings • Compatability • Hose application • Fitting types <ul style="list-style-type: none"> ○ National Pipe Thread (NPT) ○ Joint Industry Conference (JIC) ○ O-ring Boss (ORB) ○ O-ring Face (ORFS) ○ Split flange ○ Society of Automotive Engineers (SAE) ○ Reusable/Permanent |
| 10. Assemble hydraulic hoses and fittings | <ul style="list-style-type: none"> • Permanent • Reusable |

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service hydraulic components. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with mobile hydraulic systems |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS**

Competency: **D1 Describe electricity**

Objectives

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

- Define electrical terminology
- Explain basic circuit concepts
- Perform circuit calculations
- Describe magnetic theory
- Identify common electrical and electronic components
- Interpret wiring diagrams and symbols

LEARNING TASKS

1. Define electrical terminology

CONTENT

- Electrical quantities and their units and prefixes
- Voltage
- Current
- Resistance
- Power/Watts
- Circuit terminology
- Open circuit
- Closed circuit
- Short circuit
- Continuity
- Ground circuit
- Ground fault
- Series circuit
- Parallel circuit
- Series parallel circuit

2. Explain basic circuit concepts

- Sources of electricity
- Atomic theory
- Current flow
- Electrons
- Protons
- Neutron
- Conductors
- Insulators
- Semiconductors
- Ohm's Law

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>3. Perform calculations</p> <p>4. Describe magnetic theory</p> <p>5. Identify common electrical components</p> <p>6. Describe the basic function of common electronic components</p> | <ul style="list-style-type: none"> • Watt's Law • Basic circuit • Series circuits • Parallel circuits • Series parallel circuits • Source • Load • Closed circuit • Electrical relationships
 • Ohm's Law • Watt's Law • Series circuits • Parallel circuits • Series parallel circuits
 • Properties of magnetic lines of force • Terminology • Relationship to electric current • Electromagnetic induction <ul style="list-style-type: none"> ○ Types ○ Requirements • Factors affecting magnitude
 • Lamps • Switches • Relays • Solenoids • Resistors <ul style="list-style-type: none"> ○ Fixed ○ Variable • Capacitors • Motors • Alternators • Fuses
 • Diodes • Transistors |
|---|--|

LEARNING TASKS

7. Interpret basic electrical wiring diagrams

CONTENT

- Types
- Wiring schematic and diagrams
- Symbols
- Abbreviations

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS**

Competency: **D2 Use electrical testing instruments**

Objectives

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

- Use electrical measuring devices

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe how to use electrical measuring devices</p> | <ul style="list-style-type: none"> • Analog vs. digital • Voltmeters • Ammeters • Ohmmeters • Multimeters (VOM) • Amp clamp • Load tester • Capacitance tester • Continuity testers • Test lights • Safety precautions |
| <p>2. Diagnose electrical circuits</p> | <ul style="list-style-type: none"> • Voltage drops • Shorts • Grounds • Opens • Resistance • Amperage draw |

Line (GAC): D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: D3 Service, diagnose, and repair battery systems

Objectives

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

- Describe battery design and operation
- Select batteries
- Test batteries
- Maintain batteries
- Diagnose causes of battery failure
- Remove and replace batteries
- Use booster equipment and chargers
- Repair battery systems

LEARNING TASKS

1. Describe safety considerations when working with batteries

CONTENT

- Personal protection
 - Face shield
 - Apron
- Hydrogen gassing
- Acid
- Frozen batteries
- Short circuit (arcing)
- Environmental considerations
 - Recycling
 - Disposal
- Types
 - Vented
 - Sealed
 - Deep-cycle
 - Gel
 - Absorbed Glass Matt (AGM)
 - Lithium
 - Capacitor
- Plates
 - Grid material
 - Active material
- Plate straps
- Separators
- Electrolyte/Gel

2. Describe the design and construction of the various types of batteries

LEARNING TASKS

CONTENT

- | | |
|---|---|
| | <ul style="list-style-type: none"> • Case • Terminals |
| 3. Describe the chemical action that takes place in a battery during charging and discharging | <ul style="list-style-type: none"> • Charging cycle • Discharging cycle |
| 4. Select batteries | <ul style="list-style-type: none"> • Battery rating methods <ul style="list-style-type: none"> ○ Cold cranking amperes (CCA) ○ Cranking amperes (CA) ○ Reserve capacity ○ Amp hour • Physical dimensions |
| 5. Service batteries | <ul style="list-style-type: none"> • Safety precautions • Inspection • Cleaning • Terminal servicing • Charging • Replacement • Scheduled maintenance • Storage and handling |
| 6. Diagnose batteries | <ul style="list-style-type: none"> • Specific gravity • Open circuit voltage test • Load test • 3 minute fast charge test • Battery Impedance test |
| 7. Repair battery systems | <ul style="list-style-type: none"> • Battery securement • Cable connectors • Battery cable • Isolation devices • Battery enclosure |
| 8. Use booster equipment and chargers | <ul style="list-style-type: none"> • Safety • Voltage • Polarity • Amperage • Battery maintainers |

LEARNING TASKS

CONTENT

- Smart chargers
- Boosters
 - Battery
 - Jumper pack

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair battery systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer’s Specifications
- A work place or training environment
- Equipment with battery systems

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task a logical manner
- Conducting task according to manufacturer’s specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS**

Competency: **D4 Service starting and charging systems**

Objectives

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

- Describe starting and charging circuits
- Identify starting and charging circuit components
- Service starting and charging circuits

LEARNING TASKS

1. Describe starting and charging circuits

CONTENT

- Purpose
- Operation
- Connections
- System voltage
- Battery configuration
 - Series
 - Parallel
- Series parallel
- Isolation switches
- Starter motor assembly
- Alternator assembly
- Solenoids and relays
- Magnetic switch
- Thermal switch
- Ignition switch
- Neutral safety switch/clutch pedal switch
- Cables and terminals

2. Identify components of starting circuits

- Battery
- Starter motor assembly
- Solenoids and relays
- Ignition switch
- Neutral safety switch/clutch pedal switch
- Cables and terminals

3. Identify components of charging circuits

- Alternator Types
 - Brushless
 - Brushed

LEARNING TASKS

CONTENT

- Gear driven
 - Belt driven
 - Air oil cooled
 - Internal/external regulators
 - Belts
 - Cooling fins
 - Pullys
 - ECM
 - Mounting hardware

- 4. Service starting and charging circuits
 - Sensory inspection
 - Output voltage/amperage test
 - Current draw test
 - Voltage drop test
 - Belt condition and tension
 - Component removal and replacement
 - Cleaning components and connections
 - Fault codes

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service charging and starting systems. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with functional starting and charging circuit |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS**

Competency: **D5 Service electrical circuits**

Objectives

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

- Describe electrical circuits and faults
- Service consumable electrical components

LEARNING TASKS

1. Describe electrical circuits

CONTENT

- Wiring harness
- Trailer wiring circuits
 - Connectors
 - Junction box
 - Wiring harness
- Circuit identification
- Wire gauge
- Terminals/connectors
 - Crimped
 - Soldered

2. Describe sources of circuit faults

- Blown fuses
- Fusible link
- Circuit Breaker
- Connection
- Wiring

3. Service consumable electrical components

- Lamps
- Switches
- Motors
- Fuses
- Adjustment
- Calibration
- Anti-corrosion compound

Achievement Criteria

Performance	The learner will be able to service electrical circuits.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer’s Specifications • A work place or training environment • Equipment with electrical components
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer’s specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E1 Service, diagnose, and repair tires, wheels, and hubs**

Objectives

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

- Describe tires, rims, wheels, and hubs
- Describe steering geometry
- Describe traction devices
- Service tires, rims, wheels and hubs
- Diagnose tires, rims, wheels and hubs
- Repair tires, wheels, and hubs

LEARNING TASKS

1. Describe tires and rims

2. Diagnose tires and rims

3. Service tires and rims

CONTENT

- Types of tires
 - Radial
 - Bias
- Rating
 - Load range
 - Size
 - Ply
- Types of rims
 - Dayton
 - Hub pilot
 - Stud pilot
 - Multi-piece
- Inflation and monitoring systems

- Sensory inspection
- Tire wear and damage
- Wheel run out
- Air pressure
- Tread depth

- Safety precautions
- Inspection
- Rim cleanout
- Pressure
- Wheel nut torque
- Matching
- Scheduled maintenance

LEARNING TASKS

4. Repair tires and rims

5. Describe wheel hubs

6. Diagnose wheel hubs

7. Service wheel hubs

8. Repair wheel hubs

CONTENT

- Repair/replacement
- Balancing
 - Static
 - Dynamic
- Mounting
 - Runout
- Plug and patch
- Tube

- Types
 - Conventional
 - Planetary
 - Unitized
- Components
 - Bearings
 - Seals
 - Studs
 - Separator rings
- Lubrication

- Sensory inspection
- Testing
 - End play
 - Rolling resistance
 - Leaks

- Sensory inspection
- Lubrication
- Level
- Condition

- Repair/replacement
 - Bearings
 - Seals
 - Hubs
 - Studs
- Adjustment
 - Bearing end play
 - Rolling torque

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair tires, wheels, and hubs.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer’s Specifications • A work place or training environment • Equipment with tires and wheel assemblies
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer’s specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E2 Service steering systems**

Objectives

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

- Describe steering systems
- Service steering systems

LEARNING TASKS

1. Describe basic steering systems fundamentals

CONTENT

- Types
 - Truck power assist
 - Track steering
 - Wheeled equipment steering
- System Components
 - Kingpins
 - Tie-rod ends
 - Drag link
 - Tie rod
 - Spindle
 - Steering arms
 - Steering gear
 - Orbital valves/hand metering unit
 - Cylinder
 - Drive motor
 - Steering pumps/motor
 - Steering column
 - Control valves
 - Clutches

2. Service steering systems

- Sensory inspection
- Removal or replacement
- Installation
- Lubrication
 - Level
 - Condition
 - Filters
 - Grease
- Scheduled maintenance
- Adjustment
 - Drag link
 - Tie rod ends

LEARNING TASKS

CONTENT

- Axle stops
- Steering gear
- Toe
- Track tension
- Calibration

Achievement Criteria

Performance The learner will be able to service steering systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with various steering systems

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E3 Service, diagnose, and repair suspension systems**

Objectives

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

- Describe suspension systems
- Service suspension systems
- Diagnose suspension systems
- Repair suspension systems

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Describe wheeled equipment suspension systems | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Hydro pneumatic ○ Rigid ○ Rubber block ○ Oscillating axle • Components • Operation |
| 2. Service wheeled equipment suspension systems | <ul style="list-style-type: none"> • Sensory inspection • Adjustments <ul style="list-style-type: none"> ○ Pressure ○ Height • Calibration • Lubrication • Scheduled maintenance |
| 3. Diagnose wheeled equipment suspension systems | <ul style="list-style-type: none"> • Sensory inspection • Measuring <ul style="list-style-type: none"> ○ Pressure ○ Height ○ Wear |
| 4. Repair wheeled equipment suspension systems | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Adjustment |
| 5. Describe truck and trailer suspension systems | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Walking beams ○ Leaf springs ○ Air bag |

LEARNING TASKS

CONTENT

6. Service truck and trailer suspension systems

- Rubber block
- Lift axle
- Components
 - Air bag
 - Shock absorbers
 - Spring construction
 - Hangers and attachments
 - Air suspension lockout
 - Valves
- Operation

- Sensory inspection
- Adjustments
 - Pressure
 - Height
- Calibration
- Lubrication
- Scheduled maintenance

7. Diagnose truck and trailer suspension systems

- Sensory inspection
- Measuring
 - Pressure
 - Height
 - Wear

8. Repair truck and trailer suspension systems

- Sensory inspection
- Repair/replacement/rebuild
- Adjustments
- Lubrication

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair suspension systems.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with various suspension systems
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E4 Service undercarriage systems**

Objectives

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

- Describe track machine undercarriages
- Service track machine undercarriages

LEARNING TASKS

1. Describe undercarriages

CONTENT

- Types
 - Steel
 - Rubber
- Components
 - Rollers
 - Sprockets
 - Tracks
 - Idler
 - Boggies
 - Pivot shaft
 - Equalizer bar
- Operation

2. Service undercarriages

- Adjustment
- Lubrication
- Inspection
 - Measuring
 - Sensory

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E5 Service, diagnose, and repair frames**

Objectives

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

- Describe types of frames
- Diagnose frames
- Repair frames

LEARNING TASKS

1. Describe rail and frame types

CONTENT

- Types of rails
 - Materials
 - Mild steel
 - High tensile steel
 - Aluminum
 - Strength
 - Resisting bending moment (RBM)
 - Section modulus
 - Yield strength
- Types of frames
 - Channel
 - Rigid
 - Articulated
 - I beam
- Components
 - Cross members
 - Brackets
 - Mounts
 - Hardware
 - Swing Bearing
 - Fasteners
 - Grade
 - Type

2. Service frames

- Swing bearing
- Measurement
- Lubrication

3. Diagnose frames

- Sensory inspection
- Measuring

LEARNING TASKS

CONTENT

4. Repair Frames

- Projection
 - Laser
 - String
 - Ultrasonic
- Sensory inspection
- Rail replacement
- Rail sectional replacement
 - Welding procedure
 - Brace support
- Repair
 - Crack
 - Bent
 - Twisted
- Adjustments
 - Alignment

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair frames.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with various frame configurations

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	F	SERVICE, DIAGNOSE, AND REPAIR TRAILERS
Competency:	F1	Service, diagnose, and repair landing gear and trailer accessories

Objectives

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

- Describe landing gear and trailer accessories
- Service trailer accessories
- Diagnose trailer accessories
- Repair trailer accessories
- Service landing gear
- Diagnose landing gear
- Repair landing gear

LEARNING TASKS

1. Describe landing gear and trailer accessories

CONTENT

- Lift gates
 - Hydraulic
 - Mechanical
- Landing gear
 - Hydraulic
 - Electric
 - Mechanical
- Landing gear components
 - Gears
 - Cross rods
 - Support
- Trailer accessories
 - Tarping systems
 - Ladders
 - Ratchet winch
 - Aerodynamic systems
- Operation

2. Service landing gear and trailer accessories

- Operational checks
- Lubrication
- Adjustments
- Scheduled maintenance

3. Diagnose landing gear and trailer accessories

- Inspection
 - Sensory
 - Measurement
 - Operational

LEARNING TASKS

CONTENT

- | | |
|--|---|
| | <ul style="list-style-type: none"> ○ Pressure/flow ○ Voltage • Lubrication |
| 4. Repair landing gear and trailer accessories | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Adjustments |

Achievement Criteria

- | | |
|-------------|---|
| Performance | The learner will be able to service, diagnose, and repair landing gear and trailer accessories. |
| Conditions | <p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test Equipment • Manufacturer's Specifications • A work place or training environment • Equipment with various landing gear and trailer accessories |
| Criteria | <p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC):	F	SERVICE, DIAGNOSE, AND REPAIR TRAILERS
Competency:	F2	Service, diagnose, and repair coupling systems

Objectives

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

- Describe coupling systems
- Service coupling systems
- Diagnose coupling systems
- Repair coupling systems

LEARNING TASKS

1. Describe coupling systems

2. Describe couplers

CONTENT

- Trailer Combination Types
 - A train
 - B train
 - C train
- Coupling types
 - Fifth wheel
- Purpose and design
- Ratings
- Fifth wheel
 - Top plate
 - Base plate
 - Mounting brackets
 - Jaw and lock mechanisms
 - Jaw release mechanisms
 - Slide lock mechanisms
 - Safety devices
- Fifth wheel mounting types
 - Fixed
 - Sliding
 - Oscillating
- Upper coupler
 - Bolster plates
 - King pins
 - Size
 - Mounting
- Pintle
 - Draw bar
 - Pintle eye/hook
 - Bushing
 - Compensator

LEARNING TASKS

CONTENT

- | | |
|----------------------|---|
| | <ul style="list-style-type: none"> ○ Buffers <ul style="list-style-type: none"> ▪ Pneumatic ▪ Hydraulic ○ Safety chains |
| | <ul style="list-style-type: none"> • Ball <ul style="list-style-type: none"> ○ Safety chains |
| 3. Service couplers | <ul style="list-style-type: none"> • Sensory inspection • Measurement • Adjustment • Lubrication |
| 4. Diagnose couplers | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ Operational • Measurement |
| 5. Repair couplers | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Adjustments • Verification of operation |

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair coupling systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with various couplers

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	F	SERVICE, DIAGNOSE, AND REPAIR TRAILERS
Competency:	F3	Service, diagnose, and repair trailer body components

Objectives

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

- Describe trailer bodies and components
- Service trailer body components
- Diagnose trailer body components
- Repair trailer body components

LEARNING TASKS

1. Describe trailer bodies and components

CONTENT

- Types
 - Dump
 - Logging
 - Van
 - Flat deck
 - Car carrier
 - Tanker
 - Dolly
 - Low bed
 - Components
 - Frames
 - Doors
 - Hinged
 - Roll up
 - Bunks
 - Bumpers
 - Sliding bogies
 - Tanks
 - Valves
 - Manifold piping
 - Gauges
 - Transfer pump
 - Reflective tape
 - Box
 - Transfer
 - Dump
-
2. Service trailer body components
 - Sensory inspection
 - Measurement
 - Operation
 - Adjustments

LEARNING TASKS

CONTENT

- | | |
|-------------------------------------|---|
| | <ul style="list-style-type: none"> • Lubrication |
| 3. Diagnose trailer body components | <ul style="list-style-type: none"> • Sensory inspection • Measurement • Operation • Testing <ul style="list-style-type: none"> ○ Pressure ○ Valves |
| 4. Repair trailer body components | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Operation • Adjustment • Lubrication • Verification of repair |

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair trailer body components. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with a variety of trailer bodies |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	F	SERVICE, DIAGNOSE, AND REPAIR TRAILERS
Competency:	F4	Service heating and refrigeration systems

Objectives

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

- Describe heating and refrigeration systems
- Service heating and refrigeration systems

LEARNING TASKS

1. Describe heating and refrigeration systems

CONTENT

- Trailer mounted
 - Cooling unit
 - Heating unit
 - Combination unit
- Drive types
 - Fuel
 - Electric
 - Hybrid
- Components
 - Valves
 - Heat exchangers
 - Compressor
 - Generator
 - Battery
 - Electronic control module (ECM)
 - Control panel
 - Sensors
 - Switches
 - Motors
- Operational modes
 - Heating
 - Cooling
 - Defrost

2. Service heating and refrigeration systems

- Inspection
 - Sensory
 - Operational
 - Temperature
- Filters
- Lubricants
- Belts

Achievement Criteria

Performance	The learner will be able to service heating and refrigeration systems.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer’s Specifications • A work place or training environment • Equipment with heating and refrigeration units
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer’s specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	G	SERVICE, DIAGNOSE, AND REPAIR HEATING, VENTILATION, AND AIR CONDITIONING
Competency:	G1	Describe heating and air conditioning fundamentals

Objectives

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

- Identify heating and air conditioning components
- Describe the construction and operation of heating and air conditioning systems
- Describe the impact of refrigerants on the environment
- Apply legislated procedures when dealing with systems containing refrigerants

LEARNING TASKS

1. Describe principles of heating and air conditioning systems
2. Identify components of heating and air conditioning systems

CONTENT

- Describe the laws of thermodynamics
- Heater core
- Valves
- Controls
- Ducts
- Filters
- Resistor pack
- Door actuator
- Compressor
- Drive systems
- Evaporator
- Fans
- Condenser
- Receiver-drier/accumulator
- Orifice tubes/expansion valves
- Refrigerant
 - Ozone depleting potential
 - Global warming potential
 - Types
- Lubricants
 - Mineral
 - Synthetic
- Controls
- Sensors
- Hoses, piping and connectors
- Seats and gaskets

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>3. Describe the design and operation of heating and air conditioning systems</p> | <ul style="list-style-type: none"> • Heating system • Refrigeration cycle • Compressor • Evaporator • Condenser • Receiver-drier/accumulator • Orifice tubes/expansion valves • Refrigerant • Lubricants • Controls • Sensors |
| <p>4. Describe the impact of refrigerants on the environment</p> | <ul style="list-style-type: none"> • Ozone depletion • Global warming |
| <p>5. Identify legislation dealing with the use and handling of refrigerants</p> | <ul style="list-style-type: none"> • Training requirements • Certification • Jurisdictional regulations |

Line (GAC): **J SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES**

Competency: **J1 Describe protective structures**

Objectives

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

- Describe regulations related to protective structures
- Describe inspection procedures of protective structures

LEARNING TASKS

1. Describe structural components

2. Describe inspection procedures

3. Describe operational regulations

CONTENT

- Roll Over Protective Structure (ROPS)
- Falling Objects Protective Structure (FOPS)
- Operator Protective Structure (OPS)

- Damage
 - Cracks
 - Dents
 - Fatigue
 - Alterations
- Certification labeling
- Secondary escape
- Safety equipment

- Components
 - Safety glass
 - Screens

Line (GAC):	J	SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES
Competency:	J2	Service, diagnose, and repair cab structures

Objectives

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

- Describe cab, bodies, and components
- Service cab, bodies, and components
- Diagnose cab, bodies, and components
- Repair cab, bodies, and components

LEARNING TASKS

1. Describe cabs, bodies, and components

CONTENT

- Body types
 - Articulating
 - Coach
 - Transit
 - School
 - Monocoque
 - Cab types
 - Conventional
 - Cab over
 - Tilting cab
 - Cab mounting
 - Fixed
 - Air ride
 - Cushion
 - Components
 - Doors
 - Windows
 - Hood
 - Seats
 - Seat belts
 - Supplemental Restraint System (SRS)
 - Accessibility devices
 - Sleepers
 - Emergency system
 - Aerodynamic devices
 - Operation
-
2. Service cabs, bodies, and components
 - Sensory inspection
 - Components
 - Operational testing

LEARNING TASKS

CONTENT

- Restraint certification
 - Adjustment
 - Lubrication

- 3. Diagnose cabs, bodies, and components
 - Sensory inspection
 - Testing
 - Operational
 - Pressure
 - Leaks
 - Adjustment
 - Lubrication
 - Supplemental Restraint System (SRS)
 - Fault codes

- 4. Repair cabs, bodies, and components
 - Sensory inspection
 - Repair/replacement/rebuild
 - Lubrication
 - Adjustment
 - Hood
 - Cab
 - Doors
 - Windows
 - Cab suspension
 - Verification of system operation

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair cab structures. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's specifications • A work place or training environment • Equipment with cab structures |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC):	L	USE COMMUNICATION AND MENTORING TECHNIQUES
Competency:	L1	Use communication techniques

Objectives

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

- Use communication techniques
- Use digital communication technologies and platforms

LEARNING TASKS

1. Use effective communication skills

2. Use active listening

3. Use digital communication technologies and platforms

CONTENT

- Safety and information meetings
- Verbal and written instructions
- Professionalism
 - Participation
 - Responsibilites
 - Respect
- Harrassment and discrimination
- Constructive feedback
- Attention
- Clarification
- Acknowledgement of understanding
- Eye contact
- Engagement
- Open-ended questions
- Email
- Text messages
- Social media
- Record keeping
 - Apps and platforms
 - Service/work orders
 - Inspection reports

Level 2

Heavy Duty Equipment Technician

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS**

Competency: **D6 Diagnose and repair charging systems**

Objectives

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

- Describe charging system components
- Describe the design and operation of charging systems
- Inspect charging systems
- Diagnose charging systems
- Repair charging systems

LEARNING TASKS

CONTENT

- | | |
|--|--|
| <p>1. Describe the design and operation of alternator assemblies</p> | <ul style="list-style-type: none"> • Alternator <ul style="list-style-type: none"> ○ Rotor ○ Stator ○ Rectifier ○ Brushes • Regulators • Field circuits • Drive • Cooling • Electronic control module (ECM) |
| <p>2. Diagnose charging systems</p> | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ System tests ○ Component tests ○ Voltage drop ○ Amperage ○ Shorts ○ Opens ○ Grounds ○ High resistance • Adjustments • Diagnostic codes |
| <p>3. Repair charging system components</p> | <ul style="list-style-type: none"> • Sensory inspection • Removal • Bench tests • Repair/replacement/rebuild |

LEARNING TASKS

CONTENT

- Installation
- Adjustments
- Lubrication
- Verification of operation
- Scheduled maintenance
- Diagnostic codes

Achievement Criteria

Performance The learner will be able to diagnose and repair charging systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with charging circuits

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS**

Competency: **D7 Diagnose and repair starting systems**

Objectives

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

- Identify starting system components
- Describe the design and operation of starting systems
- Diagnose starting systems and their components
- Repair starting systems and their components

LEARNING TASKS

1. Describe the design and operation of starting motor assemblies

CONTENT

- Motor types
 - Series
 - Parallel
 - Series parallel
 - Shunt
- Drives
- Solenoids
- Control circuits
 - Relays
 - Switches
 - Electronic Control Module (ECM)
- Armature
- Winding
- Brushes
- Counter-Electromotive Force (CEMF)

2. Diagnose starting systems

- Sensory inspection
- Testing
 - System test
 - Component test
 - Voltage drop
 - Amperage
 - Shorts
 - Opens
 - Grounds
 - High resistance
- Fault codes

3. Repair starting system components

- Inspection

LEARNING TASKS

CONTENT

- Removal/replacement/rebuild
- Bench tests
- Installation
- Adjustments
- Lubrication
- Verifying operation

Achievement Criteria

Performance The learner will be able to diagnose and repair starting systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with a starter circuit

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of context

Line (GAC):	D	SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC COMPONENTS
Competency:	D8	Diagnose and repair electrical and electronic components and systems

Objectives

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

- Identify electrical and electronic components and systems
- Diagnose electrical and electronic systems and components
- Repair electrical and electronic systems and components

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Describe components of the electronic system | <ul style="list-style-type: none"> • Components <ul style="list-style-type: none"> ○ LED ○ Actuators ○ Circuit board ○ Multi-function controls ○ Wiring ○ Connectors ○ Communication plug ○ Sensors ○ Electronic Control Module (ECM) ○ Termination resistors • Communication protocol/data bus • Supplemental restraint system • GPS • Vehicle control systems • Guidance systems <ul style="list-style-type: none"> ○ Collision avoidance ○ Adaptive cruise control ○ Stability control |
| 2. Diagnose electrical and electronic components and systems | <ul style="list-style-type: none"> • Sensory inspection • Diagnostic tools • Test procedure • Wiring schematics |
| 3. Repair electrical components and systems | <ul style="list-style-type: none"> • Repairing connections and connectors • Replacing components • Splicing, soldering, and crimping • Applying connection sealant |

LEARNING TASKS

4. Repair electronic components and systems

CONTENT

- Replacing components
- Electrostatic discharge
- Calibrating
- Reprogramming
- Repairing wiring and connectors

Achievement Criteria

Performance The learner will be able to diagnose and repair electrical and electronic components and systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with electric and electronic components and systems

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC COMPONENTS**

Competency: **D9 Diagnose and repair vehicle and equipment management systems**

Objectives

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

- Describe a vehicle and equipment management system
- Diagnose vehicle and equipment management systems
- Repair vehicle and equipment management systems

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Describe vehicle and equipment management systems | <ul style="list-style-type: none"> • Displays • Electronic Control Module (ECM) • Communication protocol / data bus • Software |
| 2. Diagnose vehicle and equipment management systems | <ul style="list-style-type: none"> • Diagnostic procedures • Interpret test results • Test equipment • Codes |
| 3. Repair vehicle and equipment management systems | <ul style="list-style-type: none"> • Re-programming Electronic Control Module (ECM) • Parameter adjustment • Component replacement • Updating software |

Achievement Criteria

Performance The learner will be able to diagnose and repair vehicle and equipment management systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with electronic management systems

Criteria The learner will be evaluated on

- Followed safe work practices throughout entire task including lock out procedures
- Conducted in a logical manner
- Conducted according to manufacturer's specifications
- Conducted according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **D SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC COMPONENTS**

Competency: **D10 Service, diagnose, and repair electronic ignition systems**

Objectives

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

- Describe the design and operation of electronic ignition systems
- Perform limited diagnoses of electronic ignition systems
- Perform limited repairs of electronic ignition systems

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Describe the design and operation of electronic ignition systems | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Coil on plug • Primary and secondary circuit • Timing • Ignition switch and wiring • Sensors • Electronic Computer Module (ECM) • Ignition coils • High tension wires • Spark plugs • Connectors |
| 2. Service electronic ignition systems | <ul style="list-style-type: none"> • Inspection • Adjustments • Scheduled maintenance |
| 3. Diagnose electronic ignition systems | <ul style="list-style-type: none"> • Diagnostic codes • Components • Inspection • Testing • Special testing equipment |
| 4. Repair electronic ignition systems | <ul style="list-style-type: none"> • Inspection • Removal • Repair/replacement • Installation • Adjustments • Testing |

**Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND
SUPPORTING SYSTEMS**

Competency: H1 Describe engine fundamentals

Objectives

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

- Describe the combustion process
- Identify engine terminology
- Perform calculations related to engines
- Describe the principles of operation of internal combustion engines

LEARNING TASKS

1. Describe the combustion process

2. Identify engine terminology

3. Perform calculations

CONTENT

- Requirements of combustion
- Stages of combustion
- Combining air, fuel, and heat
 - Heat value and energy of fuel
 - By-products of combustion
- Compression
- Indirect/direct injection

- Power
 - Kilowatts
 - Horsepower
- Energy
 - Heat
 - BTUs
 - Joules
- Inertia
- Friction
- Bore and stroke
- Displacement
- Compression ratio
- Torque
- Volumetric efficiency

- Power
 - Kilowatts
 - Horsepower
- Displacement
- Compression ratio
- Torque

LEARNING TASKS

CONTENT

4. Describe internal combustion engine classifications

- Volumetric efficiency
- Fuel
 - Gasoline
 - Diesel
 - Compressed natural gas (CNG)/Liquefied natural gas (LNG)
 - Liquefied petroleum gas (LPG)
- Cooling
 - Air
 - Liquid
- Ignition
- Number of cylinders
- Firing order
- Cycle type
- Cylinder configuration
- Aspiration
- Rotation

5. Describe the operation of four stroke internal combustion engines

- Stroke cycle
 - Intake
 - Compression
 - Power
 - Exhaust
- Scavenging

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H2 Service engine support systems

Objectives

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

- Describe engine support systems
- Service engine support systems

LEARNING TASKS

1. Describe cooling systems

CONTENT

- Types
 - Air
 - Liquid
- Coolants
 - Types
- Components
 - Radiator/pressure cap
 - Thermostat
 - Expansion/surge tank
 - Fan system
 - Pump
- Shutter system
- Operation

2. Service cooling systems

- Sensory inspection
- Adjustment
- Testing
- Scheduled maintenance

3. Describe lubrication systems

- Types
- Components
 - Filters/bypass
 - Pumps
 - Pressure regulators
 - Coolers
- Operation

4. Service lubrication systems

- Sensory inspection
- Testing
- Scheduled maintenance
 - Oil/filter analysis

LEARNING TASKS

CONTENT

5. Describe air induction systems

- Filter service
- Oil change
- Types
 - Naturally aspirated
 - Boosted
- Components
 - Turbo charger
 - Filtration
 - Ducting
 - Positive air shut offs
 - Coolers
 - Warning devices
- Operation

6. Service air induction systems

- Sensory inspection
- Scheduled maintenance
 - Filter service

7. Describe exhaust systems

- Components
 - Turbo chargers
 - Mufflers
 - Manifold
 - Emission systems
- Operation

8. Service exhaust systems

- Sensory inspection
- Scheduled maintenance

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H3 Diagnose and repair engine support systems

Objectives

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

- Diagnose engine support systems
- Repair engine support systems

LEARNING TASKS

1. Diagnose cooling systems

2. Repair cooling systems

3. Diagnose lubrication systems

4. Repair lubrication systems

5. Diagnose air induction systems

CONTENT

- Sensory inspection
- Components
- Testing
 - Operation
 - Pressure
 - Temperature
 - Freeze point
 - Additives
 - Fluid sampling
 - Fan speed
- Fault codes

- Repair/replacement/rebuild
- Adjustments
- Verification of system operation

- Sensory inspection
- Testing
 - Pressure
 - Temperature
 - Dye
 - Oil level
 - Oil/filter analysis
- Fault codes

- Repair/replacement/rebuild
- Adjustments
- Verify system operation

- Sensory inspection
- Testing

LEARNING TASKS

CONTENT

- | | |
|---------------------------------|---|
| | <ul style="list-style-type: none"> ○ Leak ○ Pressure ○ Restriction ○ Temperature • Fault codes |
| 6. Repair air induction systems | <ul style="list-style-type: none"> • Repair/replacement/rebuild <ul style="list-style-type: none"> ○ Pressure testing • Adjustment • Calibration • Verification of system operation |
| 7. Diagnose exhaust systems | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ Leak ○ Pressure ○ Temperature • Fault codes |
| 8. Repair exhaust systems | <ul style="list-style-type: none"> • Repair/replacement/rebuild <ul style="list-style-type: none"> ○ Pressure testing • Adjustment • Calibration • Verification of system operation |

Achievement Criteria

Note: This Achievement Criteria covers competencies H2 and H3

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair engine support systems. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H4 Service diesel fuel supply systems

Objectives

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

- Describe characteristics of diesel fuel
- Describe diesel fuel supply systems
- Service diesel supply systems

LEARNING TASKS

1. Describe characteristics of diesel fuel

CONTENT

- Grades
- Viscosity
- Flash point
- Cetane
- Sulfur content
- Cloud point
- Storage
- Disposal

2. Describe diesel fuel supply systems

- Components
 - Tank
 - Lines
 - Filters
 - Low pressure pumps
 - Water separator
 - Sensors
 - Regulator
- Operation

3. Service diesel fuel supply systems

- Sensory inspection
- Priming
- Additives
- Scheduled maintenance

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H5 Diagnose and repair diesel fuel supply systems

Objectives

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

- Diagnose diesel fuel supply systems
- Repair diesel fuel supply systems

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Diagnose diesel fuel supply systems | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ Pressure ○ Leak ○ Vacuum ○ Flow ○ Fuel sampling analysis • Fault codes |
| 2. Repair diesel fuel supply systems | <ul style="list-style-type: none"> • Repair/replacement • Adjustment • Calibration • Verification of system operation |

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to diagnose and repair diesel fuel supply systems. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with diesel engines |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC): **H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS**

Competency: **H6 Describe alternative fuel systems**

Objectives

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

- Describe the characteristics of alternative fuel systems
- Identify the types of alternative fuel systems

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Describe the characteristics of alternative fuels | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Compressed natural gas (CNG) ○ Liquefied natural gas (LNG) ○ Liquefied petroleum gas (LPG) ○ Biodiesel ○ Renewable fuels • Physical properties • Heat value • Storage considerations |
| 2. Identify the components of alternative fuel systems | <ul style="list-style-type: none"> • Tank • Lines • Filters • Valves • Regulators • Heat exchangers |

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H7 Service, diagnose, and repair engines and components

Objectives

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

- Describe base engine components
- Service engine components
- Diagnose problems on a diesel engine
- Rebuild a diesel engine

LEARNING TASKS

1. Describe base engine components

CONTENT

- Head
- Valve train
- Block
- Internal components
 - Crankshaft
 - Camshaft
 - Connecting rods
 - Pistons
 - Liners
 - Bearings
- Attachments
 - Engine mounts
 - Front and rear structures

2. Service engine components

- Sensory inspection
- Adjustments
 - Valves
 - Compression brakes
 - Injectors
- Calibration

3. Perform diagnostic procedures

- Types of problems
 - Lack of power
 - Hard starting
 - Rough running
 - Frequent stalling
 - Variations in exhaust smoke
 - Abnormal engine temperature
 - Abnormal oil consumption
 - Abnormal coolant consumption

LEARNING TASKS

CONTENT

- Excessive vibration and noise
 - Fluid contamination
 - No start
 - Types of tests
 - Blow-by
 - Compression
 - Leak down
 - Boost pressure
 - Oil pressure/coolant system pressure
 - Cylinder balance
 - Fault codes
 - Performance
 - Exhaust temperature
 - Dye testing
 - Fluid/filter analysis

- 4. Prepare for overhaul
 - Sensory inspection
 - Types of overhaul
 - Inframe
 - Removal
 - Cleaning
 - Removal of attachments

- 5. Disassemble engine
 - Sensory inspection
 - Failure analysis
 - Engine measurements
 - Cleaning and handling of components
 - Component inspection
 - Determining parts and components required for reassembly

- 6. Repair engine components
 - Repair/replacement/rebuild
 - Crankshaft
 - Camshaft
 - Liners
 - Pistons
 - Bearings
 - Cylinder head

- 7. Describe base engine components
 - Assembly measurements
 - Liner protrusion

LEARNING TASKS

CONTENT

8. Service engine components

- Ring gap
- Bearing clearance
- End play
- Valve lash
- Injector adjustment
- Lubrication of components
- Timing
- Mounting of attachments
- Installation or storage preparation

- Pre-lubing system
- Priming fuel systems
- Pre-start procedure
- Start up procedure
- Engine operation monitoring
- Calibration
- Break-in procedure
- Operational checks

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair engines and components.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with functional diesel engines

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H8 Diagnose and repair mechanical fuel injection systems

Objectives

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

- Describe the components and operation of mechanical fuel injection systems
- Diagnose mechanical fuel injection systems
- Repair mechanical fuel injection systems

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Describe the theory of diesel fuel injection | <ul style="list-style-type: none"> • Requirements of injection systems • Principles • Governors |
| 2. Describe fuel injection pump systems | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Inline ○ Distributor • Components • Operation |
| 3. Diagnose fuel injection systems | <ul style="list-style-type: none"> • Sensory inspection • Procedures • Testing <ul style="list-style-type: none"> ○ Cutouts ○ Pressure ○ Flow ○ Nozzle operation |
| 4. Repair fuel injection systems | <ul style="list-style-type: none"> • Repair/replacement • Adjustments • Pump timing • Throttle linkage • Shutoff • Verification of repair |

Achievement Criteria

Performance	The learner will be able to diagnose and repair mechanical fuel injection systems.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with mechanical diesel fuel injection systems
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS

Competency: H9 Service, diagnose, and repair electronic diesel fuel systems

Objectives

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

- Service electronic fuel systems
- Diagnose electronic fuel systems
- Repair electronic fuel systems

LEARNING TASKS

1. Describe electronic diesel fuel systems

CONTENT

- Types
 - Electronic Unit Injectors (EUI)
 - Electronic Unit Pump (EUP)
 - Hydraulic Electronic Unit Injector (HEUI)
 - High Pressure Injector – Time Pressure (HPI-TP)
 - High Pressure Common Rail (HPCR)
 - Amplified Common Rail (ACR)
- Components
- Operation
- Inputs
- Processing
- Outputs

2. Service electronic fuel systems

- Sensory inspection
- Adjustments
 - Injector
- Calibration

3. Diagnose electronic fuel systems

- Sensory inspection
- Testing
 - Pressure
 - Volume
 - Leakage
 - Balance
 - Cutout
- Fault codes
- Calibration
- Components

LEARNING TASKS

4. Repair electronic fuel systems

CONTENT

- Sensory inspection
- Repair/replacement
- Adjustments
- Fuel and lube priming
- Calibration
- Fault codes
- Verification of system operation

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair electronic diesel fuel systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with electronic diesel fuel systems

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): H **SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS**

Competency: H10 Service, diagnose, and repair diesel emissions systems

Objectives

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

- Describe the causes and effects of harmful emissions
- Describe emission systems on diesel engines
- Service emission systems on diesel engines
- Diagnose emission systems on diesel engines
- Repair emission systems on diesel engines

LEARNING TASKS

1. Describe the causes and effects of harmful emissions
2. Describe emission systems on diesel engines
3. Service emission systems on diesel engines

CONTENT

- Causes
 - Combustion process
 - Byproducts
 - Effects
 - Environmental
 - Health
 - Smog
 - Legislation
-
- Components and controls
 - Diesel Particulate Filters (DPF)
 - Selective Catalytic Reduction (SCR)
 - Diesel Exhaust Fluid (DEF)
 - Diesel Oxygen Catalyst (DOC)
 - Exhaust Gas Recirculation (EGR)
 - Crankcase ventilation system
 - Electronic Control Module (ECM)
 - Sensors
 - Dosing system
 - Exhaust piping
 - Operation
 - Regeneration
 - Passive
 - Active
 - Stationary
-
- Sensory inspection
 - Calibration
 - Diesel exhaust fluid

LEARNING TASKS

CONTENT

- Level
 - Quality
 - Filters
 - Crankcase
 - Diesel Particulate Filters (DPF)
 - Diesel Exhaust Fluid (DEF)

- 4. Diagnose emission systems on diesel engines
 - Sensory inspection
 - Testing
 - Components
 - Fault codes
 - Calibration

- 5. Repair emission systems on diesel engines
 - Sensory inspection
 - Repair/replacement
 - Diesel Particulate Filters (DPF) cleaning
 - Regeneration
 - Calibration
 - Fault codes
 - Verification of system operation

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair diesel emissions systems. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with functional exhaust emissions systems |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **H SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS**

Competency: **H11 Service, diagnose, and repair engine retarder systems**

Objectives

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

- Describe engine retarder systems
- Service engine retarder systems
- Diagnose engine retarder systems
- Repair engine retarder systems

LEARNING TASKS

1. Describe engine retarder systems

2. Service engine retarder systems

3. Diagnose engine retarder systems

4. Repair engine retarder systems

CONTENT

- Types
 - Compression
 - Exhaust
 - Hydraulic
- Components
- Operation

- Sensory inspection
- Operational check
- Adjustment

- Sensory inspection
- Testing
- Measurement
- Adjustment
- Calibration
- Fault codes

- Repair/replacement/rebuild
- Adjustments
- Fault codes
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair engine retarder systems.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with engine retarder systems
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Level 3

Heavy Duty Equipment Technician

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I1	Describe power transfer systems

Objectives

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

- Describe methods of transferring power
- Describe the principles of power transfer
- Perform calculations related to power transfer

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Describe methods of transferring power | <ul style="list-style-type: none"> • Fluids • Shafts • Belts • Chains • Gears |
| 2. Describe the principles of power transfer | <ul style="list-style-type: none"> • Gear ratios <ul style="list-style-type: none"> ○ Simple ○ Compound ○ Planetary • Torque • Speed • Power flow <ul style="list-style-type: none"> ○ Truck ○ Crawler ○ Excavator ○ Loader • Gear types • Gear nomenclature |
| 3. Perform calculations | <ul style="list-style-type: none"> • Gear ratios <ul style="list-style-type: none"> ○ Simple ○ Compound ○ Planetary • Torque • Speed |

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I2	Service, diagnose, and repair clutches

Objectives

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

- Describe the principles and operation of clutches and related components
- Service clutches and related components
- Diagnose clutches and related components
- Repair clutches and related components

LEARNING TASKS

1. Describe clutches and related components

CONTENT

- Clutch types
 - Diaphragm
 - Pull/push
 - Self-adjusting
 - Over centre
 - Jaw
 - Wet/dry
 - Single/multi-plate
 - Magnetic
 - Band
- Clutch actuation systems
- Operation

2. Service clutches and related components

- Sensory inspection
- Adjustment
 - Linkage
 - Internal/external
- Operational check
- Lubrication

3. Diagnose clutches and related components

- Sensory inspection
- Measurement
 - Wear
 - Clearance
 - Pressure
- Operational test
- Calibration
- Fault codes

LEARNING TASKS

4. Repair clutches and related components

CONTENT

- Repair/replacement
- Measurement
- Adjustment
- Free play
- Clutch brake
- Lubrication
- Calibration
- Verification of system operation

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair clutches.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with various clutch types

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I3	Service, diagnose, and repair manual transmissions

Objectives

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

- Describe manual transmissions
- Service manual transmissions
- Diagnose manual transmissions
- Repair manual transmissions

LEARNING TASKS

1. Describe manual transmissions

2. Service manual transmissions

3. Diagnose manual transmissions

4. Repair manual transmissions

CONTENT

- Types
 - Single countershaft
 - Multiple countershaft
- Components
- Shifting operation
 - Mechanical
 - Pneumatic
- Lubrication
- Operation
- Sensory inspection
- Operational checks
- Scheduled maintenance
 - Lubrication
 - Filters
- Sensory inspection
- Testing
 - Pressure
 - Temperature
 - Operational
 - Fluid/filter analysis
- Repair/replacement/rebuild
- Adjustments
- Lubrication
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair manual transmissions.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with manual transmission
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I4	Service, diagnose, and repair automated transmissions

Objectives

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

- Describe automated transmissions
- Service automated transmissions
- Diagnose automated transmissions
- Repair automated transmissions

LEARNING TASKS

1. Describe automated transmissions

2. Service automated transmissions

3. Diagnose automated transmissions

4. Repair automated transmissions

CONTENT

- Types
 - Actuation
 - Gear arrangement
- Components
 - Electronic Control Module (ECM)
 - Sensors
 - Solenoids
 - Actuators
 - Wiring harness
- Operation
- Lubrication
- Sensory inspection
- Operational checks
- Scheduled maintenance
- Lubrication
- Filters
- Sensory inspection
- Testing
 - Pressure
 - Operational
 - Voltage
- Components and controls
- Calibration
- Fault codes
- Repair/replacement/rebuild
- Lubrication
- Adjustment

LEARNING TASKS

CONTENT

- Calibration
- Fault codes
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair automated transmissions.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with automated transmissions
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p>

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I5	Service, diagnose, and repair automatic transmissions and torque converters

Objectives

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

- Describe the principles of planetary gear sets
- Describe the operation of torque converters and automatic transmissions
- Diagnose torque converters and automatic transmissions
- Repair torque converters and automatic transmissions

LEARNING TASKS

1. Describe torque converters

CONTENT

- Types
 - Conventional
 - Fluid coupler
- Components
- Fluids
- Operation
 - Stages
 - Phases

2. Describe automatic transmissions

- Types
 - Electronic/hydraulic control
 - Planetary
 - Countershaft
- Components
- Electronic Control Module (ECM)
- Power flow
- Controls
- Lubrication
- Operation
 - Hydraulic circuit
 - Electrical circuit

3. Service automatic transmissions and torque converters

- Sensory Inspection
- Fluid level
- Filter
- Fluid/filter analysis
- Operational check
- Calibration

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 4. Diagnose automatic transmissions and torque converters | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ Stall ○ Temperature ○ Pressure ○ Electrical ○ Operational ○ Fluid/filter analysis • Calibration • Fault codes |
| 5. Repair automatic transmissions and torque converters | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Components • Adjustments • Lubrication • Fluid flush • Calibration • Verification of system operation |

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair automatic transmissions and torque converters. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with automatic transmissions |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I6	Service, diagnose, and repair power shift transmissions

Objectives

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

- Describe power shift transmissions
- Service power shift transmissions
- Diagnose power shift transmissions
- Repair power shift transmissions

LEARNING TASKS

1. Describe torque converters

CONTENT

- Types
 - Conventional
 - Divider
 - Fluid coupler
- Components
- Fluids
- Operation
 - Stages
 - Phases

2. Describe power shift transmissions

- Types
 - Mechanical/hydraulic control
 - Electronic/hydraulic control
 - Planetary
 - Countershaft
 - Constant Variable Transmission (CVT)
- Components
- Electronic Control Module (ECM)
- Power flow
- Controls
- Lubrication
- Operation
 - Hydraulic circuit
 - Electrical circuit

3. Service power shift transmissions and torque converters

- Sensory Inspection
- Fluid level
- Filter
- Fluid/filter analysis

LEARNING TASKS

CONTENT

- | | |
|---|---|
| | <ul style="list-style-type: none"> • Operational check • Calibration |
| 4. Diagnose power shift transmissions and torque converters | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ Stall ○ Temperature ○ Pressure ○ Electrical ○ Operational ○ Fluid/filter analysis • Calibration • Fault codes |
| 5. Repair power shift transmissions and torque converters | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Components • Adjustments • Lubrication • Fluid flush • Calibration • Verification of system operation |

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair power shift transmissions. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with powershift transmission |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I7	Service, diagnose, and repair drivelines

Objectives

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

- Describe drivelines and their components
- Service drivelines and their components
- Diagnose drivelines and their components
- Repair drivelines and their components

LEARNING TASKS

1. Describe drivelines and components

CONTENT

- Types
 - Main drive shaft
 - Power takeoff shaft (PTO)
- Arrangements
 - Parallel
 - Non-parallel
- Components
 - U-joint
 - Slipshaft
 - Steady bearing
 - Yoke
 - Tube
 - Shear pins
- Operation
- Working angles
- Phasing
- Balance
- Total Indicated Runout (TIR)

2. Service drivelines and components

- Sensory inspection
- Lubrication
- Scheduled maintenance

3. Diagnose drivelines and components

- Sensory inspection
- Testing
 - Runout
 - Balance
 - Angles
 - Phasing
 - Measurement

LEARNING TASKS

CONTENT

- | | |
|-------------------------------------|--|
| 4. Repair drivelines and components | <ul style="list-style-type: none"> • Components
 • Repair/replacement <ul style="list-style-type: none"> ○ Phasing ○ Alignment • Adjustments • Lubrication • Verification of system operation |
|-------------------------------------|--|

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to service, diagnose, and repair drivelines. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer’s Specifications • A work place or training environment • Equipment with drivelines |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer’s specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I8	Service, diagnose, and repair drive axles

Objectives

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

- Describe drive axles
- Service drive axles
- Diagnose drive axles
- Repair drive axles

LEARNING TASKS

1. Describe drive axles

CONTENT

- Drive axle types
 - Single axle
 - Tandem axle
 - Tridem axle
- Drive types
 - Conventional
 - Electric
- Components
 - Differentials
 - Lockers
 - Limited slip
 - Axle shafts
 - Semi-floating
 - Full-floating
 - Gears
 - Thrust pin
- Controls and circuits
- Mounting
- Lubrication
- Cooling
- Operation

2. Service drive axles

- Sensory inspections
- Operational check
- Lubrication
- Filter/breathers

3. Diagnose drive axles

- Sensory inspection
- Testing
 - Pressure

LEARNING TASKS

CONTENT

4. Repair drive axles

- Temperature
- Operational
- Measurement
- Fluid/filter analysis
- Fault codes
- Repair/replacement/rebuild
- Measurements
 - Backlash
 - Runout
 - Gear pattern
 - Preload
 - Thrust pin clearance
- Adjustments
- Lubrication
- Calibration
- Verification of system operation

Achievement Criteria

Performance The learner will be able to service, diagnose, and repair drive axles.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with drive axles

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I9	Service, diagnose, and repair final drives

Objectives

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

- Describe final drives
- Service final drives
- Diagnose final drives
- Repair final drives

LEARNING TASKS

1. Describe final drives

2. Service final drives

3. Diagnose final drives

4. Repair final drives

CONTENT

- Types
 - Inboard
 - Outboard
 - Chain
 - Gear
 - Planetary
 - Bull and pinion
- Components
- Operation
- Sensory inspection
- Lubrication
- Filters
- Operational test
- Sensory inspection
- Testing
 - Measurement
 - Operational
 - Filter/oil analysis
 - Failure analysis
- Repair/replacement/rebuild
- Adjustments
- Lubrication
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair final drives.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with final drives
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I10	Service, diagnose, and repair drivetrain retarders

Objectives

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

- Describe drivetrain retarders
- Service drivetrain retarders
- Diagnose drivetrain retarders
- Repair drivetrain retarders

LEARNING TASKS

1. Describe drivetrain retarders

2. Service drivetrain retarders

3. Diagnose drivetrain retarders

4. Repair drivetrain retarders

CONTENT

- Types
 - Hydraulic
 - Electric
- Components
- Operation
- Sensory inspection
- Measurement
 - Air gap
 - End play
- Lubrication
- Sensory inspection
- Testing
 - Operational
 - Pressure
 - Temperature
 - Electrical
- Fault codes
- Failure analysis
- Repair/replacement/rebuild
- Adjustments
- Calibration
- Verification system operation

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair drivetrain retarders.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with drivetrain retarders
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I11	Service, diagnose, and repair winches

Objectives

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

- Describe winches
- Service winches
- Diagnose winches
- Repair winches

LEARNING TASKS

1. Describe winches

2. Service winches

3. Diagnose winches

4. Repair winches

CONTENT

- Types
 - Mechanical
 - Electrical
 - Hydraulic
- Components
 - Wire Rope
 - Drums
 - Clutch/brake
- Operation
- Sensory inspection
- Lubrication
- Adjustments
- Sensory inspection
- Testing
 - Operational
 - Pressure
 - Electrical
 - Measurement
- Failure analysis
- Repair/replacement/rebuild
- Adjustments
- Lubrication
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair winches.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer’s Specifications • A work place or training environment • Equipment with winch
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer’s specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS
Competency:	I12	Service, diagnose, and repair power take-offs and transfer cases

Objectives

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

- Describe power take-offs and transfer cases
- Service power take-offs and transfer cases
- Diagnose power take-offs and transfer cases
- Repair power take-offs and transfer cases

LEARNING TASKS

1. Describe power take-offs

CONTENT

- Components
- Drive Source
 - Engine
 - Transmission
 - Transfer cases
 - Electric
- Mounting
- Controls
 - Hydraulic
 - Electric
 - Air
- Lubrication
- Operation
- Applications

2. Service power take-offs

- Sensory inspection
- Lubrication
- Filters
- Operational check

3. Diagnose power take-offs

- Sensory inspection
- Testing
 - Operational
 - Pressure
 - Electrical
 - rpm
 - Measurement
 - Filter/lube analysis
- Controls
 - Mechanical

LEARNING TASKS

CONTENT

- | | |
|----------------------------|---|
| | <ul style="list-style-type: none"> ○ Electrical/electronic • Fault codes • Failure analysis |
| 4. Repair power take-offs | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Adjustments <ul style="list-style-type: none"> ○ Backlash ○ Preload • Lubrication • Verification of system operation |
| 5. Describe transfer cases | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Coupled ○ Divorced ○ Drop box • Components • Mounting • Controls • Lubrication • Operation |
| 6. Service transfer cases | <ul style="list-style-type: none"> • Sensory inspection • Lubrication • Filter/breathers |
| 7. Diagnose transfer cases | <ul style="list-style-type: none"> • Sensory inspection • Testing <ul style="list-style-type: none"> ○ Operational ○ Pressure ○ Electrical • Controls • Fault codes • Failure analysis |
| 8. Repair transfer cases | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Adjustments • Lubrication • Calibration • Verification of system operation |

Achievement Criteria

Performance	The learner will be able to service, diagnose, and repair power take-offs and transfer cases.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with power take-offs and transfer cases
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p>

Level 4

Heavy Duty Equipment Technician

Line (GAC):	C	SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS
Competency:	C2	Diagnose and repair advanced hydraulic systems

Objectives

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

- Diagnose hydraulic systems
- Repair hydraulic systems and components
- Repair electronic hydraulic systems

LEARNING TASKS

1. Describe hydraulic systems and components

CONTENT

- Pumps
 - Pressure compensated
 - Load sensing (HD only)
- Electronic components
 - Solenoids
 - Sensors
 - Electronic Control Module (ECM)
 - Controls
- Actuators
 - Cylinders
 - Motors
- Valves
 - Pressure
 - Flow
 - Directional
- System types
 - Closed loop
 - Open loop

2. Diagnose hydraulic systems

- Safety precautions
- Diagnostic procedures
- Test equipment
 - Pressure gauges
 - Flow meters
 - Temperature sensors
 - Electronic Service Tool (EST)
- Cycle times
- Diagnostic codes
- Manufacturer's procedures

3. Repair hydraulic systems and components

- Safety precautions
- Components

LEARNING TASKS

CONTENT

- Reservoirs
 - Pumps
 - Actuators
 - Control valves
 - Accumulators
 - Coolers
 - Connecting lines
 - Fluids
 - Inspection
 - Removal/installation
 - Repair/replacement/rebuild
 - System flushing

- 4. Repair electronic hydraulic systems
 - Safety precautions
 - Sensors
 - Actuators
 - Wiring and connectors
 - Electronic Control Module (ECM)
 - Communication protocols
 - Removal/installation
 - Repair/replacement
 - Verification of systems operation

Achievement Criteria

- Performance** The learner will be able to diagnose and repair advanced hydraulic systems.
- Conditions** The learner will be given
- Tools
 - Test equipment
 - Manufacturer's Specifications
 - A work place or training environment
 - Equipment with mobile hydraulic systems
- Criteria** The learner will be evaluated on
- Following safe work practices throughout entire task including lock out procedures
 - Conducting task in a logical manner
 - Conducting task according to manufacturer's specifications
 - Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	E	SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION
Competency:	E6	Diagnose and repair wheeled equipment steering

Objectives

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

- Describe the components and operation of steering systems
- Diagnose steering systems
- Repair steering systems

LEARNING TASKS

1. Describe steering systems

2. Diagnose steering systems

3. Repair steering systems

CONTENT

- Types
 - Orbital
 - Hydraulic
 - Electric
 - Supplemental
- Components
- Operation
- Safety precautions/lockouts
- Sensory inspection
- Measurement
- Testing
 - Pressure/flow
 - Leakage
 - Operational
 - Cycle times
- Fault codes
- Repair/replacement/rebuild
- Adjustments
- Lubrication
- Calibration
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to diagnose and repair wheeled equipment steering.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with various steering configurations
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E7 Diagnose and repair track machine steering**

Objectives

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

- Describe track machine steering systems
- Diagnose track machine steering systems
- Repair track machine steering systems

LEARNING TASKS

1. Describe steering systems

CONTENT

- Types
 - Clutch
 - Hydrostatic
 - Differential
- Components
 - Pump
 - Motor
 - Valves
 - Control system
 - Electronic Control Module (ECM)
- Operation

2. Diagnose steering systems

- Sensory inspection
- Testing
- Measurements
 - Pressure/flow
 - Cycle times
 - Operational
- Fault codes

3. Repair steering systems

- Repair/replacement/rebuild
- Adjustments
- Lubrication
- Calibration
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to diagnose and repair track machine steering.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with various steering configurations
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): **E SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION**

Competency: **E8 Diagnose and repair undercarriage**

Objectives

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

- Describe track machine undercarriages
- Diagnose track machine undercarriages
- Repair track machine undercarriages

LEARNING TASKS

1. Describe undercarriages

CONTENT

- Types
 - Steel
 - Rubber
- Components
 - Rollers
 - Sprockets
 - Tracks
 - Idler
 - Boggies
 - Pivot shaft
 - Equalizer bar
- Operation

2. Diagnose undercarriages

- Operation
- Components
- Sensory inspection
- Measurement
- Lubrication

3. Repair undercarriages

- Repair/replacement/rebuild
- Adjustments
- Lubrication
- Verification of system operation

Achievement Criteria

Performance	The learner will be able to diagnose and repair undercarriage.
Conditions	<p>The learner will be given</p> <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's Specifications • A work place or training environment • Equipment with various undercarriage configurations
Criteria	<p>The learner will be evaluated on</p> <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	G	SERVICE, DIAGNOSE, AND REPAIR HEATING, VENTILATION, AND AIR CONDITIONING
Competency:	G2	Service, diagnose, and repair heating and air conditioning systems

Objectives

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

- Service heating and air conditioning systems
- diagnose heating and air conditioning systems
- Repair heating and air conditioning systems

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Service heating and air conditioning systems | <ul style="list-style-type: none"> • Operation testing • Cabin filter • Belt tension/condition • Cleaning heat exchangers |
| 2. Diagnose heating and air conditioning systems | <ul style="list-style-type: none"> • Diagnostic procedures <ul style="list-style-type: none"> ○ Pressure ○ Temperature • Manufacturer's procedures • Diagnostic codes • Components <ul style="list-style-type: none"> ○ Electrical ○ Mechanical ○ Drive • Inspection • Sensory inspection • Leak detection methods <ul style="list-style-type: none"> ○ Vacuum ○ Pressure ○ Dye ○ Electronic |
| 3. Repair heating and air conditioning systems | <ul style="list-style-type: none"> • Safety hazards • Recovery, evacuation, and recharge • Component removal and replacement • Adjustments <ul style="list-style-type: none"> ○ Ducting ○ Doors ○ Clutch • Pressure/leak testing |

LEARNING TASKS

CONTENT

- Environmental considerations
- Verification of system operation

Achievement Criteria

Performance The learner will be able to diagnose and repair heating and air conditioning systems.

Conditions The learner will be given

- Tools
- Test equipment
- Manufacturer's Specifications
- A work place or training environment
- Equipment with HVAC systems

Criteria The learner will be evaluated on

- Following safe work practices throughout entire task including lock out procedures
- Conducting task in a logical manner
- Conducting task according to manufacturer's specifications
- Conducting task according to work place requirements

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC): J SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES

Competency: J3 Service, diagnose, and repair sound suppression systems

Objectives

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

- Describe sound suppression systems
- Service sound suppression systems
- Diagnose sound suppression systems
- Repair sound suppression systems

LEARNING TASKS

1. Describe sound suppression systems
2. Service sound suppression systems
3. Diagnose sound suppression systems
4. Repair sound suppression systems

CONTENT

- Types
- Components
 - Foam
 - Insulation
 - Panels
 - Fasteners
 - Seals
 - Mounts
- Sensory inspection
- Operational check
- Sensory inspection
- Testing
 - Decibel level
 - Vibration
- Repair/replacement
- Verification of system operation

Line (GAC): **J** **SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES**

Competency: **J4** **Diagnose and repair attachments and accessories**

Objectives

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

- Describe attachments and accessories
- Service attachments and accessories
- Diagnose attachments and accessories
- Repair attachments and accessories

LEARNING TASKS

1. Describe attachments and accessories

CONTENT

- Types
 - Ground Engaging Tools (GET)
 - Booms and arms
 - Compactor
 - Rock breaker
 - Grapple
 - Logging
- Accessories
 - Auto greasers
 - Platforms
 - Anti-vandalism equipment
- Components
- Operation

2. Service attachments and accessories

- Sensory inspection
- Measurement
- Testing
 - Pressure
 - Flow
 - Cycle time
 - Operational
- Lubrication
- Fluids
- Calibration
- Adjustment
- Installation

3. Diagnose attachments and accessories

- Sensory inspection
- Measurement

LEARNING TASKS

CONTENT

- | | |
|---------------------------------------|--|
| 4. Repair attachments and accessories | <ul style="list-style-type: none"> • Testing <ul style="list-style-type: none"> ○ Pressure ○ Flow ○ Cycle time ○ Operational ○ Voltage • Lubrication • Fluids • Calibration • Adjustment • Fault codes |
| | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Lubrication • Adjustments • Calibration • Verification of system operation |

Achievement Criteria

- | | |
|-------------|---|
| Performance | The learner will be able to service, diagnose, and repair attachments and accessories. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • Manufacturer's specifications • A work place or training environment • Equipment with attachments and accessories |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Following safe work practices throughout entire task including lock out procedures • Conducting task in a logical manner • Conducting task according to manufacturer's specifications • Conducting task according to work place requirements. <p><i>Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts</i></p> |

Line (GAC): J SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES

Competency: J5 Diagnose and repair pneumatic systems

Objectives

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

- Describe pneumatic systems
- Service pneumatic systems
- Diagnose pneumatic systems
- Repair pneumatic systems

LEARNING TASKS

1. Describe pneumatic systems

CONTENT

- Types
 - Industrial compressors
 - Starting systems
 - Drill systems
- Compressor Types
 - Reciprocating
 - Rotary vane
 - Rotary screw
- Components
 - Motors
 - Actuators
 - Valves
 - Dryers
 - Regulators
 - Solenoid
 - Hoses/lines
 - Reservoirs
- Operation

2. Service pneumatic systems

- Sensory inspection
- Adjustments
 - Pressure
 - Flow
- Filters
- Fluids
- Dryer
- Lubrication
- Scheduled maintenance

3. Diagnose pneumatic systems

- Sensory inspection

LEARNING TASKS

CONTENT

- | | |
|-----------------------------|--|
| | <ul style="list-style-type: none"> • Testing <ul style="list-style-type: none"> ○ Pressure ○ Flow ○ Cycle times ○ Operational • Fault codes |
| 4. Repair pneumatic systems | <ul style="list-style-type: none"> • Repair/replacement/rebuild • Adjustments • Calibration • Verification of system operation |

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to diagnose and repair pneumatic systems. |
| Conditions | The learner will be given <ul style="list-style-type: none"> • Tools • Test equipment • manufacturers Specifications • A work place or training environment • Equipment with various pneumatic devices |
| Criteria | The learner will be evaluated on <ul style="list-style-type: none"> • Followed safe work practices throughout entire task including lock out procedures • Conducted in a logical manner • Conducted according to manufacturer's specifications • Conducted according to work place requirements. |

Throughout the term of the apprenticeship, the learner must conduct the above performance a multiple of times and in a variety of contexts

Line (GAC):	K	SERVICE, DIAGNOSE, AND REPAIR HYBRID AND ELECTRIC VEHICLES (EV)
Competency:	K1	Service, diagnose, and repair hybrid vehicles and hybrid equipment

Objectives

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

- Describe hybrid systems
- Service hybrid systems
- Diagnose hybrid systems
- Repair hybrid systems

LEARNING TASKS

1. Describe hybrid systems

CONTENT

- Types
 - Series
 - Parallel
 - Combination
 - Extended range
- Operation
 - Drive
 - Regenerative braking
- Safety
 - High voltage
 - High amperage
 - Ground fault protection system
- High voltage Identification
- Components
 - High voltage battery
 - Capacitor
 - Motors/generator
 - Controls
 - Invertor/converters
 - Cables
 - Electronic Control Module (ECM)
 - Sensors
- Accessory drive motors
 - Air conditioning
 - Compressor
 - Cooling fans
 - Hydraulics
 - Power steering

LEARNING TASKS

2. Service hybrid systems

3. Diagnose hybrid systems

4. Repair hybrid systems

CONTENT

- Sensory inspection
 - Lubrication
 - Filters
 - Wiring
 - Lock out procedure
 - Cooling system
-
- Specialized tooling
 - Codes
 - Test procedures
 - Communication protocols
-
- Specialized tooling
 - Components
 - High voltage battery
 - Capacitor
 - Motors/generator
 - Controls
 - Invertor/converters
 - Cables
 - Electronic Control Module (ECM)
 - Sensors
 - Accessory drive motors
 - Air conditioning
 - Compressor
 - Cooling fans
 - Hydraulics
 - Power steering

Line (GAC):	K	SERVICE, DIAGNOSE, AND REPAIR HYBRID AND ELECTRIC VEHICLES (EV)
Competency:	K2	Service, diagnose, and repair electric vehicles (EV)

Objectives

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

- Describe electric vehicles (EV)
- Service electric vehicles (EV)
- Diagnose electric vehicles (EV)
- Repair electric vehicles (EV)

LEARNING TASKS

1. Describe an electrical drive system

CONTENT

- Operation
 - Drive
 - Regenerative braking
- Safety
 - High voltage
 - High amperage
 - Ground fault protection system
- Components
 - High voltage battery
 - Capacitor
 - Motors/generator
 - Controls
 - Invertor/converters
 - Cables
 - Electronic Control Module (ECM)
 - Sensors
- Accessory drive motors
 - Air conditioning
 - Compressor
 - Cooling fans
 - Hydraulics
 - Power steering

2. Service electric drive systems

- Lubricant
- Cooling system
 - Coolant
 - Cooling fans

3. Diagnose electric drive systems

- Specialized tooling
- Codes

LEARNING TASKS

4. Repair electric drive systems

CONTENT

- Test procedures
- Communication protocols

- Specialized tooling
- Components
 - High voltage battery
 - Capacitor
 - Motors/generator
 - Controls
 - Invertor/converters
 - Cables
 - Electronic Control Module (ECM)
 - Sensors
- Accessory drive motors
 - Air conditioning
 - Compressor
 - Cooling fans
 - Hydraulics
 - Power steering

Line (GAC):	L	USE COMMUNICATION AND MENTORING TECHNIQUES
Competency:	L2	Use mentoring techniques

Objectives

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

- Use effective communication and mentorship skills
- Use mentoring techniques

LEARNING TASKS

1. Use effective communication and mentorship skills

CONTENT

- Safety and information meetings
- Verbal and written instructions
- Professionalism
 - Participation
 - Responsibilities
 - Respect
- Harassment and discrimination
- Learning/teaching strategies
 - Identifying learner needs
 - Assessing skills
 - Demonstrating skills
- Mentorship best practices
 - Patience
 - Empathy
 - Understanding
 - Building trust
 - Encouraging
 - Giving constructive feedback

- ## 2. Use mentoring techniques

Section 4

ASSESSMENT GUIDELINES

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:		HEAVY DUTY EQUIPMENT TECHNICIAN LEVEL 1	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	PERFORM OCCUPATIONAL SKILLS	11%	12%
B	SERVICE, DIAGNOSE, AND REPAIR BRAKES	19%	19%
C	SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS	15%	15%
D	SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS	17%	18%
E	SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION	20%	21%
F	SERVICE, DIAGNOSE, AND REPAIR TRAILERS	10%	10%
G	SERVICE, DIAGNOSE, AND REPAIR HEATING, VENTILATION, AND AIR CONDITIONING	3%	0%
J	SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES	4%	5%
L	USE COMMUNICATION AND MENTORING TECHNIQUES	1%	0%
	Total	100%	100%
In-school theory/practical subject competency weighting		50%	50%
Final in-school percentage score		IN-SCHOOL %	
In-school Percentage Score Combined theory and practical subject competency multiplied by		80%	
Standardized Level Exam Percentage Score The exam score is multiplied by		20%	
Final Percentage Score		FINAL%	

Assessment Guidelines – Level 2

Level 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:		HEAVY DUTY EQUIPMENT TECHNICIAN LEVEL 2	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
D	SERVICE, DIAGNOSE, AND REPAIR ELECTRICAL AND ELECTRONIC SYSTEMS	25%	25%
H	SERVICE, DIAGNOSE, AND REPAIR ENGINES AND SUPPORTING SYSTEMS	75%	75%
	Total	100%	100%
In-school theory/practical subject competency weighting		50%	50%
Final in-school percentage score		IN-SCHOOL %	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	FINAL%

Assessment Guidelines – Level 3

Level 3 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:		HEAVY DUTY EQUIPMENT TECHNICIAN LEVEL 3	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
I	SERVICE, DIAGNOSE, AND REPAIR POWERTRAINS		
	I1 Describe power transfer systems	6%	0%
	I2 Service, diagnose, and repair clutches	9%	6%
	I3 Service, diagnose, and repair manual transmissions	11%	16%
	I4 Service, diagnose, and repair automated transmissions	10%	7%
	I5 Service, diagnose, and repair automatic transmissions and torque converters	12%	15%
	I6 Service, diagnose, and repair power shift transmissions	12%	15%
	I7 Service, diagnose, and repair drivelines	8%	5%
	I8 Service, diagnose, and repair drive axles	12%	12%
	I9 Service, diagnose, and repair final drives	10%	15%
	I10 Service, diagnose, and repair drivetrain retarders	3%	3%
	I11 Service, diagnose, and repair winches	3%	3%
	I12 Service, diagnose, and repair power take-offs and transfer cases	4%	3%
	Total	100%	100%
In-school theory/practical subject competency weighting		50%	50%
Final in-school percentage score		IN-SCHOOL %	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	FINAL%

Assessment Guidelines – Level 4

Level 4 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:		HEAVY DUTY EQUIPMENT TECHNICIAN LEVEL 4	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
C	SERVICE, DIAGNOSE, AND REPAIR HYDRAULICS	50%	51%
E	SERVICE, DIAGNOSE, AND REPAIR FRAMES, STEERING, AND SUSPENSION	26%	28%
G	SERVICE, DIAGNOSE, AND REPAIR HEATING, VENTILATION, AND AIR CONDITIONING	10%	11%
J	SERVICE, DIAGNOSE, AND REPAIR STRUCTURAL COMPONENTS AND ACCESSORIES	5%	10%
K	SERVICE, DIAGNOSE, AND REPAIR HYBRID AND ELECTRIC VEHICLES (EV)	7%	0%
L	USE COMMUNICATION AND MENTORING TECHNIQUES	2%	0%
	Total	100%	100%
In-school theory/practical subject competency weighting		50%	50%
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 exam.		IN-SCHOOL %	

All apprentices who complete level 4 of the Heavy Duty Equipment Technician program with a FINAL level mark of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.

SkilledTradesBC will enter the apprentices Heavy Duty Equipment Technician Red Seal Interprovincial examination mark in SkilledTradesBC DA. A minimum mark of 70% on the examination is required for a pass.

Section 5

TRAINING PROVIDER STANDARDS

Facility Requirements

Classroom Area

- Recommended 2.5 Sq. meters per student
- Projection screen, multimedia projector, whiteboard or similar
- Seating and tables suitable for lecturing
- Compliance with all safety codes

Shop Area

- Recommended 25 Sq. meters per student
- Meet all safety, fire, and environmental codes
- Good lighting
- Appropriate lifting cranes as required to move industry equipment
- Approved ventilation systems

Lab Requirements

- Recommended 10 Sq. meters per student
- Computer labs on-site

Student Facilities

- 1 locker per student
- Study areas
- Computer labs
- Food facility
- Hand wash facility
- Washroom facility

Instructor's Office Space

- Recommended 3.5 Sq. Meters

Other

- Storage space for classroom and shop props
- Parking space for heavy equipment and trucks
- Outside machine/truck wash bay

Tools and Equipment

Shop Equipment

Required Safety Equipment

- Aerial work platform
- Apron
- Arc-rated faceshield/helmet
- Arc-rated protective clothing
- Emergency backup lighting
- Eye wash station
- Face shield
- Fall arrest equipment
- Fall prevention equipment
- Fire extinguisher
- Fireproof blanket
- First aid station
- Gas mask
- Gloves
- Goggles
- Hearing protection
- High voltage gloves
- High voltage safety hook
- Ladder
- Leather gloves
- Respirator
- Safety boots
- Safety cage
- Safety glasses
- Safety hat
- Splash suit

Other Required Equipment

- Air compressor
- Axle stand
- Battery charger
- Battery load/starting system tester
- Bearing heater
- Bleeding equipment
- Booster cable
- Bottle/axle jack
- Cable hoist
- Chain hoist
- Component heating or cooling equipment
- Computer, portable diagnostic computer
- Crack detecting equipment
- Cutting and welding torch set
- Cylinder cart and tank
- Diagnostic equipment
- Dolly
- Drill: bench, hand drivers, twist, air

- Engine rotator
- Fast charger
- Floor hoist
- Forklift
- Fuel recovery and storage system
- Grinder: bench, hand, valve
- Honing equipment
- Hydraulic floor jack
- Hydraulic hand jack
- Hydraulic transmission jack
- Leak detection equipment
- Nitrogen charging equipment
- Parts wash station
- Press: arbor, spring, hydraulic, bushing, shop, mechanical
- Pressure washer
- Printer
- Puller: bearing, gear, heavy duty, reamer
- Refrigerant recycling cart
- Retrieval and storage equipment
- Safety equipment
- Scanning tool
- Shop crane
- Sling/cable/chain
- Spreader bar
- Support stand
- Tire guard
- Transmission jack
- Welding equipment

Recommended

- Alignment tool
- Analyzer: gas, infrared, vibration meter
- Black light
- Coolant recycling unit
- Oil recovery and storage tank
- Overhead crane

Student Equipment (supplied by school)

Required

- 1/4, 3/8, and 1/2 inch drive socket sets
- Adjustable wrench
- Bar (pry, aligning, heel)
- Battery post and clamp cleaner, battery
- Battery terminal puller
- Brass drift
- Center punch
- Chisel
- Digital multimeter

- Feeler gauge set
- File
- Hacksaw and blade
- Hammer: impact, rubber, sledge, air, slide, soft blow
- Hex key set, metric and imperial
- High voltage hand tools
- Jumper wire
- Magnetic pick-up tool (telescopic, flex)
- Metric and imperial steel rule
- Micrometer
- Pick (o-ring, seal)
- Pin punch
- Pipe wrench
- Pliers: insulated, snap ring, torque, punch
- Scraper
- Screwdriver
- Tape measure
- Test light
- Tool chest
- Universal joint
- Utility knife
- Wire brush
- Wire crimper and stripper
- Wire cutter, plier cutters, shears
- Wrench set, combination (metric & imperial)
- Wrench set, flare nut (metric & imperial)

Recommended

- Belt tension gauge
- Borescope
- Depth micrometer
- Dial gauge
- Feeler gauge
- Flowmeter
- Hydrometer
- Inside micrometer
- Level
- Pressure gauge
- Pull-type scale
- Pyrometer
- Small hole gauge
- Steel ruler

- Stethoscope
- Straight edge
- Tachometer
- Telescoping gauge
- Temperature gauge
- Test light
- Thermometer
- Timing gauge
- Tire gauge
- Vacuum gauge

Student Equipment (supplied by student)***Required Safety Equipment***

- Coveralls
- Safety boots (CSA approved)
- Safety glasses (CSA approved)

Recommended Safety Equipment

- High visabilty coveralls
- Mechanic gloves

Reference Materials

Recommended Resources

- SkilledTradesBC: www.skilledtradesbc.ca
- WorkSafeBC: www.worksafebc.com

Recommended Texts

Level one:

- Fundamentals of Medium/Heavy Duty Commercial Vehicle Systems
Wright, Gus and Owen C. Duffy
Jones and Bartlett Learning
- Fundamentals of Mobile Heavy Equipment
Duffy, Owen C., et al.
Jones and Bartlett Learning

Level two:

- Fundamentals of Medium/Heavy Duty Diesel Engines
Wright, Gus
Jones and Bartlett Learning
- Diesel Engine Technology: Fundamentals, Service, Repair
Mack, James P., et al.
The Goodheart-Willcox Company, Inc.

Level three:

- Fundamentals of Medium/Heavy Duty Commercial Vehicle Systems
Wright, Gus and Owen C. Duffy
Jones and Bartlett Learning
- Fundamentals of Mobile Heavy Equipment
Duffy, Owen C., et al.
Jones and Bartlett Learning

Level four:

- Fundamentals of Medium/Heavy Duty Commercial Vehicle Systems
Wright, Gus, and Owen C. Duffy
Jones and Bartlett Learning
- Fundamentals of Mobile Heavy Equipment
Duffy, Owen C., et al.
Jones and Bartlett Learning

Instructor Requirements

Occupation Qualification

The instructor must possess:

- Heavy Duty Equipment Technician – Certificate of Qualification with Interprovincial Red Seal endorsement; or
- Truck & Transport Mechanic – Certificate of Qualification with Interprovincial Red Seal endorsement

Work Experience

A minimum of 10 years of experience working in the industry as a journeyperson.

Instructional Experience and Education

It is preferred that the instructor also possesses one of the following:

- Grade 12 or equivalent
- Instructor Diploma

Appendices

Appendix A Acronyms

ABS	Anti-lock braking system
ACR	Amplified Common Rail
AGM	Absorbed Glass Matt
API	American Petroleum Institute
CA	Cranking amperes
CCA	Cold cranking amperes
CEMF	Counter-Electromotive Force
CNG	Compressed natural gas
CVSE	Commercial Vehicle Safety Enforcement Regulations
CVT	Constant Variable Transmission
DEF	Diesel Exhaust Fluid
DO	Diesel Oxygen Catalyst
DPF	Diesel Particulate Filters
ECM	Electronic Control Module
EGR	Exhaust Gas Recirculation
ESDC	Employment and Social Development Canada
SDC	Electronic Service Tool
EST	Electronic Unit Injectors
EUI	Electronic Unit Pump
EUP	Electric Vehicle
FOPS	Falling Objects Protective Structure
GET	Ground Engaging Tools
GPS	Global Positioning System
HEUI	Hydraulic Electronic Unit Injector
HPCR	High Pressure Common Rail
HPI-TP	High Pressure Injector – Time Pressure
ICBC	Insurance Corporation of British Columbia
ISO	International Organization for Standardization
JIC	Joint Industry Conference
LNG	Liquified natural gas
LPG	Liquified petroleum gas
NPT	National Pipe Thread
OPS	Operator Protective Structure
ORS	O-ring Boss
ORFS	O-ring Face
P.A.S.S.	Pull, Aim, Squeeze, Sweep
PPE	Personal Protective Equipment
PTO	Power Takeoff Shaft
RPM	Revolutions per Minute
SAE	Society of Automotive Engineers

SCR	Selective Catalytic Reduction
SMAW	Shielded Metal Arc Welding
SRS	Supplemental Restraint System
TDG	Transportation of Dangerous Goods Act
TIR	Total Indicated Runout
VOM	Volt-Ohm Milliammeter
WHMIS	Workplace Hazardous Materials Information System

Appendix B

Summary of Achievement Criteria

Achievement Criteria are included for competencies that require a practical assessment. The intent of including Achievement Criteria in the Program Outline is to ensure consistency in training across the many training institutions in British Columbia. Their purpose is to reinforce the theory and to provide a mechanism for evaluation of the learner's ability to apply the theory to practice. It is important that these performances be observable and measurable and that they reflect the skills spelled out in the competency. The conditions under which these performances will be observed and measured must be clear to the learner as well as the criteria by which the learner will be evaluated. The learner must also be given the evaluation criteria.

The performance spelled out in the Achievement Criteria is a suggested performance and is not meant to stifle flexibility of delivery. Training providers are welcome to substitute other practical performances that measure similar skills and attainment of the competency. Multiple performances may also be used to replace individual performances where appropriate.

The following tables summarize the practical assessments for each level. **For details, please refer to the Achievement Criteria following the competency in the Program Content section.**

HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 1 SUMMARY OF ACHIEVEMENT CRITERIA	
SUBJECT COMPETENCY	ACHIEVEMENT CRITERIA TASK
A3 Use hand tools, power tools, and shop equipment	The learner will be able to use hand tools, power tools, and shop equipment.
A10 Use cutting and welding equipment	The learner will be able to use cutting and welding equipment.
B1 Service and repair hydraulic brakes and parking brakes	The learner will be able to service and repair hydraulic brakes and parking brakes.
B2 Service and repair hydraulic power brakes and ABS systems	The learner will be able to service hydraulic components.
B3 Service and repair air brakes	The learner will be able to service and repair air brakes.
C1 Service hydraulic components	The learner will be able to service hydraulic components.
D3 Service, diagnose, and repair battery systems	The learner will be able to service, diagnose, and repair battery systems.
D4 Service starting and charging systems	The learner will be able to service charging and starting systems.
D5 Service electrical circuits	The learner will be able to service electrical circuits.
E1 Service, diagnose, and repair tires, wheels, and hubs	The learner will be able to service, diagnose, and repair tires, wheels, and hubs.
E2 Service steering systems	The learner will be able to service steering systems.
E3 Service, diagnose, and repair suspension systems	The learner will be able to service, diagnose, and repair suspension systems.
E5 Service, diagnose, and repair frames	The learner will be able to service, diagnose, and repair frames.
F1 Service, diagnose, and repair landing gear and trailer accessories	The learner will be able to service, diagnose, and repair landing gear and trailer accessories.
F2 Service, diagnose, and repair coupling systems	The learner will be able to service, diagnose, and repair coupling systems.
F3 Service, diagnose, and repair trailer body components	The learner will be able to service, diagnose, and repair trailer body components.

F4 Service heating and refrigeration systems	The learner will be able to service heating and refrigeration systems.
J2 Service, diagnose, and repair cab structures	The learner will be able to service, diagnose, and repair cab structures

HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 2 SUMMARY OF ACHIEVEMENT CRITERIA

SUBJECT COMPETENCY	ACHIEVEMENT CRITERIA TASK
D6 Diagnose and repair charging systems	The learner will be able to diagnose and repair charging systems.
D7 Diagnose and repair starting systems	The learner will be able to diagnose and repair starting systems.
D8 Diagnose and repair electrical and electronic components and systems	The learner will be able to diagnose and repair electrical and electronic components and systems.
D9 Diagnose and repair vehicle and equipment management systems	The learner will be able to diagnose and repair vehicle and equipment management systems.
H3 Diagnose and repair engine support systems	The learner will be able to: <ul style="list-style-type: none"> • Service engine support systems. <i>(H2)</i> • Diagnose and repair engine support systems. <i>(H3)</i>
H5 Diagnose and repair diesel fuel supply systems	The learner will be able to diagnose and repair diesel fuel supply systems.
H7 Service, diagnose, and repair engines and components	The learner will be able to service, diagnose, and repair engines and components.
H8 Diagnose and repair mechanical fuel injection systems	The learner will be able to diagnose and repair mechanical fuel injection systems.
H9 Service, diagnose, and repair electronic diesel fuel systems	The learner will be able to service, diagnose, and repair electronic diesel fuel systems.
H10 Service, diagnose, and repair diesel emissions systems	The learner will be able to service, diagnose, and repair diesel emissions systems.
H11 Service, diagnose, and repair engine retarder systems	The learner will be able to service, diagnose, and repair engine retarder systems.

**HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 3
SUMMARY OF ACHIEVEMENT CRITERIA**

SUBJECT COMPETENCY	ACHIEVEMENT CRITERIA TASK
I2 Service, diagnose, and repair clutches	The learner will be able to service, diagnose, and repair clutches.
I3 Service, diagnose, and repair manual transmissions	The learner will be able to service, diagnose, and repair manual transmissions.
I4 Service, diagnose, and repair automated transmissions	The learner will be able to service, diagnose, and repair automated transmissions.
I5 Service, diagnose, and repair automatic transmissions and torque converters	The learner will be able to service, diagnose, and repair automatic transmissions and torque converters.
I6 Service, diagnose, and repair power shift transmissions	The learner will be able to service, diagnose, and repair power shift transmissions.
I7 Service, diagnose, and repair drivelines	The learner will be able to service, diagnose, and repair drivelines.
I8 Service, diagnose, and repair drive axles	The learner will be able to service, diagnose, and repair drive axles.
I9 Service, diagnose, and repair final drives	The learner will be able to service, diagnose, and repair final drives.
I10 Service, diagnose, and repair drivetrain retarders	The learner will be able to service, diagnose, and repair drivetrain retarders.
I11 Service, diagnose, and repair winches	The learner will be able to service, diagnose, and repair winches.
I12 Service, diagnose, and repair power take-offs and transfer cases	The learner will be able to service, diagnose, and repair power take-offs and transfer cases.

**HEAVY DUTY EQUIPMENT TECHNICIAN – LEVEL 4
SUMMARY OF ACHIEVEMENT CRITERIA**

SUBJECT COMPETENCY	ACHIEVEMENT CRITERIA TASK
C2 Diagnose and repair advanced hydraulic systems	The learner will be able to diagnose and repair advanced hydraulic systems.
E6 Diagnose and repair wheeled equipment steering	The learner will be able to diagnose and repair wheeled equipment steering.
E7 Diagnose and repair track machine steering	The learner will be able to diagnose and repair track machine steering.
E8 Diagnose and repair undercarriage	The learner will be able to diagnose and repair undercarriage.
G2 Service, diagnose, and repair heating and air conditioning systems	The learner will be able to diagnose and repair heating and air conditioning systems.
J4 Diagnose and repair attachments and accessories	The learner will be able to service, diagnose, and repair attachments and accessories.
J5 Diagnose and repair pneumatic systems	The learner will be able to diagnose and repair pneumatic systems.