PROGRAM OUTLINE

Heavy Duty Equipment Technician
(Heavy Duty Equipment Mechanic)
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www.itabc.ca

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HEAVY DUTY EQUIPMENT MECHANIC
PROGRAM OUTLINE

2003

Developed by
Industry Training Authority
Province of British Columbia
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Heavy Duty Equipment Mechanic
Introduction

Foreword

This Program Outline is issued by the Industry Training and Apprenticeship Commission for use in apprenticeship training classes sponsored by the Industry Training and Apprenticeship Commission. Indentured apprentices will be directed to the Apprenticeship Training classes in accordance with the General Regulations made pursuant to the “Industry Training and Apprenticeship Act” of British Columbia.

It is intended as a guide for instructors of apprenticeships. 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. It is the responsibility of employers to ensure safety training for the apprentice working on their worksite.

The “Content” portion of each competency is there as a guide only, and is not intended to be exhaustive.

A ‘Glossary’ of verbs is included at the end of the Program Outline. It is there to clarify the intent of the “Learning Objective” and “Learning Task” statements. Also included at the end of the Program Outline, is a Competency Profile chart and a list of Tools and Equipment necessary to offer the training.

The Program Outline was prepared with the advice and assistance of representatives of management and labour and in cooperation with the Industry Training and Apprenticeship Commission.

SAFETY ADVISORY

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

The Program Outline was prepared with the advice and direction of an industry steering committee convened initially by the ITAC. Members include:

- Leni Balaban
- Brian Haugen
- Tom Kozar
- Ray Oksanen
- Dick Syms
- Ed Wilk

The Industry Training Authority would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Heavy Duty Equipment Mechanic occupation.
# How to Use this Document

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

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

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/ Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Training Provider Standards</strong></td>
<td>Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program</td>
<td>Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own</td>
<td>Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors</td>
<td>Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment</td>
</tr>
</tbody>
</table>
Section 2

PROGRAM OVERVIEW

Heavy Duty Equipment Mechanic
Program Overview

Program Credentialing Model

Occupation Name: Heavy Duty Equipment (Mechanic) Technician
Model Type: Single Track

RECOMMENDATION FOR CERTIFICATION

Heavy Duty Equipment Mechanic Level 4
Technical Training: 180 hours (6 weeks*)
Work-Based Training: 6000 hours total
Interprovincial Red Seal Exam

Heavy Duty Equipment Mechanic Level 3
Technical Training: 180 hours (6 weeks*)
Accumulate Work-Based Training hours

Heavy Duty Equipment Mechanic Level 2
Technical Training: 180 hours (6 weeks*)
Accumulate Work-Based Training hours

Heavy Duty Equipment Mechanic Level 1
Technical Training: 180 hours (6 weeks*)
Accumulate Work-Based Training hours

Entry Level Technical Training (ELTT)
"Module 1"
Technical Training: 900 hours (30 weeks*)

APPRENTICESHIP - DIRECT ENTRY

* Suggested duration based on 30-hour week

Certificate of Qualification (C of Q)
Certificate of Apprenticeship (C of A)
Certificate of Completion (C of C)
Work-Based Training (WBT)
Apprentices will be assessed fairly and accurately throughout the program on the various skills required to be a professional tradesperson. Assessment activities are designed to provide feedback and allow for further skill development of skills that have been identified as essential for on the job performance.

The forms of assessment used in this program are described below.

<table>
<thead>
<tr>
<th>Completion Requirement</th>
<th>Evidence of Achievement</th>
<th>Level of Achievement Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 Technical Training</td>
<td>Practical and Written Assessments</td>
<td>Minimum Score of 70%</td>
</tr>
<tr>
<td>Level 2 Technical Training</td>
<td>Practical and Written Assessments</td>
<td>Minimum Score of 70%</td>
</tr>
<tr>
<td>Level 3 Technical Training</td>
<td>Practical and Written Assessments</td>
<td>Minimum Score of 70%</td>
</tr>
<tr>
<td>Level 4 Technical Training</td>
<td>Practical and Written Assessments</td>
<td>Minimum Score of 70%</td>
</tr>
<tr>
<td>Certificate of Qualification Exam</td>
<td>Written Assessment</td>
<td>Minimum Score of 70%</td>
</tr>
</tbody>
</table>
Program Overview

Occupational Analysis Chart
HEAVY DUTY EQUIPMENT MECHANIC

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

<table>
<thead>
<tr>
<th>Service Equipment and Attachments</th>
<th>Service Frames</th>
<th>Service Suspension Systems</th>
<th>Service Steering Systems</th>
<th>Service Working Attachments</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
<td>D4</td>
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<td>E</td>
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<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Service Track Machines and Attachments</td>
<td>Service Undercarriages</td>
<td>Service Final Drives</td>
<td>Service Steering Systems</td>
<td>Service Working Attachments</td>
</tr>
<tr>
<td></td>
<td>E1</td>
<td>E2</td>
<td>E3</td>
<td>E4</td>
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<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Service Wire Rope and Whinches</td>
<td>Service Wire Rope</td>
<td>Service Winches</td>
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</tr>
<tr>
<td>F</td>
<td>F1</td>
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<td>E</td>
<td></td>
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</tr>
<tr>
<td>Service Hydraulic Systems</td>
<td>Describe Hydraulic Brake Systems</td>
<td>Service Hydraulic Systems</td>
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</tr>
<tr>
<td>G</td>
<td>G1</td>
<td>G2</td>
<td></td>
<td></td>
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<td>E 1</td>
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<td>E 1</td>
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<tr>
<td>Service Hydraulic Brake Systems</td>
<td>Describe Hydraulic Brake Systems</td>
<td>Service Hydraulic Brake Systems</td>
<td>Service Power Brake Systems</td>
<td>Service Anti-lock Brake Systems</td>
</tr>
<tr>
<td>H</td>
<td>H1</td>
<td>H2</td>
<td>H3</td>
<td>H4</td>
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</table>
## Program Overview

<table>
<thead>
<tr>
<th>SERVICE POWER TRAIN COMPONENTS</th>
<th>Describe Power Transfer Systems</th>
<th>Service Clutches</th>
<th>Service Standard Transmissions</th>
<th>Service Drive Lines</th>
<th>Service Drive Axles</th>
</tr>
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<tbody>
<tr>
<td>Q</td>
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<td>Q2</td>
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</table>

<table>
<thead>
<tr>
<th>SERVICE AIR CONDITIONING SYSTEMS</th>
<th>Describe the Fundamentals of Air Conditioning</th>
<th>Service Air Conditioning Systems</th>
<th>Apply Legislation Governing CFCs and Retrofitting of Air Conditioning Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>R1</td>
<td>R2</td>
<td>R3</td>
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<tr>
<td></td>
<td>4</td>
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</tbody>
</table>
## Training Topics and Suggested Time Allocation ELTT

### HEAVY DUTY EQUIPMENT MECHANIC

<table>
<thead>
<tr>
<th>ELTT</th>
<th>% of Time Allocated to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of Time</td>
</tr>
<tr>
<td>Line A</td>
<td></td>
</tr>
<tr>
<td><strong>Use Safe Work Practices</strong></td>
<td>6%</td>
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<tr>
<td>A-1 Apply the Workers’ Compensation Act in the Workplace</td>
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</tr>
<tr>
<td>A-2 Apply Safety Practices for Trade Areas</td>
<td></td>
</tr>
<tr>
<td>A-3 Use Legislated Handling Practices for Environmentally Hazardous Materials</td>
<td>✓</td>
</tr>
<tr>
<td>A-4 Use Occupational First-aid Level 1</td>
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</tr>
<tr>
<td>Line B</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Prepare for Employment</strong></td>
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</tr>
<tr>
<td>B-1 Describe the Heavy Duty Mechanic Trade</td>
<td>✓</td>
</tr>
<tr>
<td>B-2 Describe Expectations and Responsibilities of Employers and Employees</td>
<td>✓</td>
</tr>
<tr>
<td>B-3 Use Job Search Techniques</td>
<td>✓</td>
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<tr>
<td>Line C</td>
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<tr>
<td><strong>Apply Work Practices and Procedures</strong></td>
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</tr>
<tr>
<td>C-1 Use shop Resources and Record Keeping Practices</td>
<td>✓</td>
</tr>
<tr>
<td>C-2 Use Hand tools, Power tools and Shop Equipment</td>
<td>✓</td>
</tr>
<tr>
<td>C-3 Lift Loads</td>
<td>✓</td>
</tr>
<tr>
<td>C-4 Use Fasteners and Fittings</td>
<td>✓</td>
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<tr>
<td>C-5 Use Lubricants</td>
<td>✓</td>
</tr>
<tr>
<td>C-6 Service Bearings and Seals</td>
<td>✓</td>
</tr>
<tr>
<td>C-7 Use Oxy-Fuel and Shielded Metallic Welding Equipment</td>
<td>✓</td>
</tr>
<tr>
<td>C-8 Operate Equipment</td>
<td>✓</td>
</tr>
<tr>
<td>C-9 Describe Diagnostic Procedures</td>
<td>✓</td>
</tr>
<tr>
<td>Line D</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Service Heavy Duty Wheeled Equipment and Attachments</strong></td>
<td>✓</td>
</tr>
<tr>
<td>D-1 Service Tires, Wheels and Hubs</td>
<td>✓</td>
</tr>
<tr>
<td>D-2 Service Frames</td>
<td>✓</td>
</tr>
<tr>
<td>D-3 Service Suspension Systems</td>
<td>✓</td>
</tr>
<tr>
<td>D-4 Service Steering Systems</td>
<td>✓</td>
</tr>
<tr>
<td>D-5 Service Working Attachments</td>
<td>✓</td>
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<tr>
<td>Line E</td>
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<tr>
<td><strong>Service Track Machines and Attachments</strong></td>
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<td>E-1 Service Undercarriage</td>
<td>✓</td>
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<tr>
<td>E-2 Service Final Drives</td>
<td>✓</td>
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<tr>
<td>E-3 Service Steering Systems</td>
<td>✓</td>
</tr>
<tr>
<td>E-4 Service Working Attachments</td>
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## Training Topics and Suggested Time Allocation

### HEAVY DUTY EQUIPMENT MECHANIC

<table>
<thead>
<tr>
<th>Line</th>
<th>ELTT</th>
<th>Training Topic</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<td>F</td>
<td>Service Wire Ropes and Winches</td>
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<td>100%</td>
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<tr>
<td>F-1</td>
<td>Service Wire Ropes</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>F-2</td>
<td>Service Winches</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>G</td>
<td>Service Hydraulic Systems</td>
<td>10%</td>
<td>20%</td>
<td>80%</td>
<td>100%</td>
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<tr>
<td>G-1</td>
<td>Describe Hydraulic Systems</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>G-2</td>
<td>Service Hydraulic Systems</td>
<td>✓</td>
<td>✓</td>
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<td>H</td>
<td>Service Hydraulic Brake Systems</td>
<td>5%</td>
<td>75%</td>
<td>25%</td>
<td>100%</td>
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<tr>
<td>H-1</td>
<td>Describe Hydraulic Brake Systems</td>
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<tr>
<td>H-2</td>
<td>Service Hydraulic Brake Systems</td>
<td>✓</td>
<td>✓</td>
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<td>H-3</td>
<td>Service Power Brake Systems</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>I</td>
<td>Service Air Brake Systems</td>
<td>7%</td>
<td>50%</td>
<td>50%</td>
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<tr>
<td>I-1</td>
<td>Service Air Brake Systems</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>J</td>
<td>Service Alternative Brake Systems</td>
<td>5%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
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<td>J-1</td>
<td>Describe Dynamic Brake Systems</td>
<td>✓</td>
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<tr>
<td>J-2</td>
<td>Service Expanding Tube Type Brakes</td>
<td>✓</td>
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<tr>
<td>J-3</td>
<td>Service Multi-Disc Brake Systems</td>
<td>✓</td>
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<tr>
<td>K</td>
<td>Service Air Operated Systems</td>
<td>5%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
<td></td>
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<tr>
<td>K-1</td>
<td>Service Industrial Compressors and Components</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>L</td>
<td>Service Diesel Engines</td>
<td>5%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
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<tr>
<td>L-1</td>
<td>Described the Theory of Internal Combustion Engines</td>
<td>✓</td>
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<td>L-2</td>
<td>Remove and Install Diesel Engines</td>
<td>✓</td>
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<td>L-4</td>
<td>Service Engine Support Systems</td>
<td>✓</td>
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<tr>
<td>M</td>
<td>Service Electrical And Electronic Systems</td>
<td>5%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
<td></td>
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<tr>
<td>M-1</td>
<td>Describe Basic Principles of Electricity</td>
<td>✓</td>
<td></td>
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<tr>
<td>M-2</td>
<td>Identify Common Electrical and Electronic Components</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>M-3</td>
<td>Use Electrical Testing Instruments</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>M-4</td>
<td>Service Electrical / Electronic Circuits</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>M-5</td>
<td>Service Batteries</td>
<td>✓</td>
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<td>M-6</td>
<td>Service Starting Systems</td>
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<tr>
<td>M-7</td>
<td>Service Charging Systems</td>
<td>✓</td>
<td>✓</td>
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### Training Topics and Suggested Time Allocation

#### HEAVY DUTY EQUIPMENT MECHANIC

<table>
<thead>
<tr>
<th>ELTT</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
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<td>N-2 Describe Propane Fuel Systems</td>
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<td>Q-1 Describe Power Transfer Systems</td>
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<td>Q-3 Service Standard Transmissions</td>
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**Total Percentage for Heavy Duty Mechanic** ELTT 100%
## Program Overview

### Training Topics and Suggested Time Allocation Level 1

#### HEAVY DUTY EQUIPMENT MECHANIC

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<td>C-9 Describe Diagnostic Procedures</td>
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<td>I-2 Service Anti-lock Brake Systems</td>
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<td>I-3 Service Air Over Hydraulic Brake Systems</td>
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<td>J-1 Describe Dynamic Brake Systems</td>
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<td>J-2 Service Expanding Tube Type Systems</td>
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<td>J-3 Service Multi-Disc Brake Systems</td>
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**Total Percentage for Heavy Duty Mechanic Level 1** 100%
## Program Overview

### Training Topics and Suggested Time Allocation Level 2

**HEAVY DUTY EQUIPMENT MECHANIC**

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<td>C-5</td>
<td>Use Lubricants</td>
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<td>C-9</td>
<td>Describe Diagnostic Procedures</td>
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<td>Line J</td>
<td>Service Alternative Brake Systems</td>
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<td>Service Diesel Engines</td>
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<td>Use Electrical Testing Instruments</td>
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<td>M-4</td>
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**Total Percentage for Heavy Duty Mechanic Level 2** 100%
# Program Overview

## Training Topics and Suggested Time Allocation Level 3

### HEAVY DUTY EQUIPMENT MECHANIC

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<tr>
<td>C-9</td>
<td>Describe Diagnostic Procedures</td>
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<td>Identify Common Electrical and Electronic Components</td>
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<td>M-3</td>
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Total Percentage for Heavy Duty Mechanic Level 3: 100%
## Training Topics and Suggested Time Allocation Level 4

### HEAVY DUTY EQUIPMENT MECHANIC

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<td>Service Bearings and Seals</td>
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<td>Line J</td>
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<td>Service Clutches</td>
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<td>Service Standard Transmission</td>
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<td>Service Drive Axles</td>
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<td>Service Machine Final Drives</td>
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<td>Service Torque Converters / Diverters</td>
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<td>Q-8</td>
<td>Service Power Shift and Automatic Transmission</td>
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<tr>
<td>Line R</td>
<td>Service Air Conditioning Systems</td>
<td>8%</td>
<td>75%</td>
<td>25%</td>
<td>100%</td>
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<td>R-1</td>
<td>Describe the Fundamentals of Air Conditioning</td>
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<td>R-2</td>
<td>Service Air Conditioning Systems</td>
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<tr>
<td>R-3</td>
<td>Apply legislation Governing CFCs and Retrofitting of Air Conditioning Systems</td>
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**Total Percentage for Heavy Duty Mechanic Level 4**: 100%
Section 3

PROGRAM CONTENT

Heavy Duty Equipment Mechanic
ELTT (Module 1)
Heavy Duty Equipment Mechanic
Line A: USE SAFE WORK PRACTICES

Competency: A-1 Apply the Workers’ Compensation Act in the Workplace

Objectives:
1. The learner will be able to describe the application of the parts of the Workers’ Compensation Act outlined in the Occupational Health and Safety Regulations.
2. The learner will be able to locate and apply the Parts of the Occupational Health and Safety Regulation as it applies to the Heavy Duty Mechanics’ workplace.

LEARNING TASKS

1. Define terms used in the Workers’ Compensation Act
   - Definitions, Section 1 of the Act

2. Describe the conditions under which compensation will be paid (Book 1)
   - Part 1, Division 2 of the Act

3. State the general duties of employers, employees and others (Book 1)
   - Part 2, Division 3, Sections 115-124 of the Act

4. State the Workers’ Compensation Act requirements for the reporting of accidents (Book 1)
   - Part 1, Division 5, Section 53 and 54 of the Act

5. State the “Core Requirements” of the Occupational Health and Safety Regulation (Book 1)
   - Definitions
   - Application
     - Rights and responsibilities
     - Health and safety programs
     - Investigations and reports
     - Workplace inspections
     - Rights to refuse work
     - General conditions
     - Building and equipment safety
     - Emergency preparedness
     - Preventing violence
     - Working alone
     - Ergonomics
     - Illumination
     - Indoor air quality
     - Smoking and lunchrooms

6. Locate the “General Hazard Requirements” of the Occupational Health and Safety Regulations (Book 2)
   - Chemical and biological substances
   - Substance specific requirements
   - Noise, vibration, radiation and temperature
   - Personal protective clothing and equipment
   - Confined spaces
   - De-energization and lockout
   - Fall protection
   - Tools, machinery and equipment
   - Ladders, scaffolds and temporary work platforms
Program Content
ELTT (Module 1)

- Cranes and hoists
- Rigging
- Mobile equipment
- Transportation of workers
- Traffic control
- Electrical safety
  - low voltage
  - high voltage
  - limits of approach
Program Content
ELTT (Module 1)

Line A: USE SAFE WORK PRACTICES
 Competency: A-2 Apply Safety Practices for Trade Areas

Objectives:
1. The learner will be able to apply personal safety measures.
2. The learner will be able to identify and use shop emergency equipment.
3. The learner will be able to prevent, identify and extinguish various classes of fires.

LEARNING TASKS

1. Apply personal safety precautions and procedures
   - Personal apparel
     - clothing
     - hair and beard
     - jewellery
   - Personal protection
     - head
     - hands
     - lungs
     - eyes
     - ears
     - feet
   - Safety meetings
   - Housekeeping
   - Equipment and machine lock-out
   - Ventilation systems
   - Clear head
   - Horseplay
   - Respect for others’ safety
   - Constant awareness of surroundings
   - Lifting

2. Lock-out heavy duty equipment prior to service
   - WCB requirements
   - Electrical isolation (night switch)
   - Tag
   - Key in pocket

3. Locate shop emergency equipment and means of egress
   - Emergency shutoffs
   - Fire control systems
   - Eye wash facilities
   - Emergency exits
   - First aid facilities
   - Emergency contact/phone numbers
   - Outside meeting place
   - Disaster meeting place

4. Describe the conditions necessary to support a fire
   - Air
   - Fuel
   - Heat
5. Describe the classes of fires according to the materials being burned

6. Apply preventive fire safety precautions when working near, handling or storing flammable liquids or gases, combustible materials and electrical apparatus

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

8. Describe the procedure for using a fire extinguisher

- Class A
- Class B
- Class C
- Class D
- Symbols and colours
- Fuels
  - diesel
  - gasoline
  - propane
  - natural gas
- Ventilation
  - purging
- Lubricants
- Oily rags
- Combustible metals
- Aerosols
- Warning others and fire department
- Evacuation of others
- Fire contained and not spreading
- Personal method of egress
- Training
- P.A.S.S
  - pull
  - aim
  - squeeze
  - sweep
Program Content
ELTT (Module 1)

Line A: USE SAFE WORK PRACTICES

Objectives:
1. The learner will be able to describe the purpose of the Workplace Hazardous Materials Information System (WHMIS) Regulations.
2. The learner will be able to explain the contents of Material Safety Data Sheets (MSDS)
3. The learner will be able to explain the contents of a WHMIS label.
4. The learner will be able to apply WHIMIS regulations.

LEARNING TASKS

1. State the legislation that requires suppliers of hazardous materials to provide MSDSs and label products as a condition of sale and importation
   - Hazardous Product Act
   - Controlled Product Regulations
   - Ingredient disclosure list
   - Hazardous Materials Information Review Act
   - Hazardous Materials Information Review Regulations
2. State the purpose of the Workplace Hazardous Materials Information System (WHMIS)
   - Protection of Canadian workers from the adverse effects of hazardous materials through the provision of relevant information while minimizing the economic impact on industry and the disruption of trade
   - Recognition of rights
     - workers
     - employers
     - suppliers
     - regulators
3. Describe the key elements of WHIMIS
   - Material safety data sheets (MSDSs)
   - Labelling of containers of hazardous materials
   - Worker education programs
4. Describe the responsibilities of suppliers under WHMIS
   - Provide
     - MSDSs
     - Labels
5. Describe the responsibilities of employers under WHMIS
   - Provide
     - MSDSs
     - Labels
     - work education programs in the workplace
6. Describe information to be disclosed on a MSDS

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

7. Identify symbols found on WHMIS labels and their meaning

- Compressed gasses
- Flammable and combustible materials
- Oxidizing materials
  - Poisonous and infectious materials
    - materials causing immediate and serious toxic effects
    - materials causing other toxic effects
    - biohazardous infectious materials
- Corrosive materials
- Dangerously reactive materials

8. Apply WHMIS regulations as they apply to hazardous materials used in the shop

- Use, storage and disposal of
  - Solvents
  - Caustic cleaners
  - Cleaning solutions
  - Alcohol used for cleaning
  - Gasoline
  - Diesel fuel
  - L.P.G
  - C.N.P
  - Asbestos
  - Battery acid
  - Refrigerants
  - Brake fluid
  - Antifreeze
  - Lubricants
  - Tracer dyes

9. Identify current environmental standards

- ISO 9000
- Environmental protection agency (EPA)
- Hazardous Materials (HAZMAT)
Line A: USE SAFE WORK PRACTICES
Competency: A-4  Apply Occupational First Aid Level 1

Objectives:
1. The learner will obtain a valid Occupational First-aid Level 1 Certificate

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<tr>
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<th>CONTENT</th>
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<td>1. Obtain valid Occupational First-aid Level 1</td>
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<td>Certificate</td>
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Line B: PREPARE FOR EMPLOYMENT

Competency: B-1 Describe the Heavy Duty Mechanics Trade

Objectives:
1. The worker will be able to describe the heavy-duty mechanics' trade and working conditions

LEARNING TASKS

1. Describe the areas and types of equipment worked on by heavy duty mechanics

2. Describe the current heavy duty mechanics' trade

3. Describe the range of working conditions

4. Describe business and labour relationships

5. Describe legislation affecting employment

CONTENT

- Scope from the national occupational analysis
- Current apprenticeship model
- Job opportunities
  - location
  - advancements
  - specialization
  - dealerships
  - fleets
  - independence
- Pay scale
- Hours of work
- Working environment
- quality control
- Union
- Non-union
- Labour standards
- Labour relation codes
- Workers' Compensation Act
- Human Rights Act
- Health Act
- WHIMIS
- Environmental legislation
- Gas Safety Branch
- Motor Vehicle Act
- ICBC
Line B: PREPARE FOR EMPLOYMENT

Competency: B-2 Describe Expectations and Responsibilities of Employers and Employees

Objectives:
1. The learner will be able to demonstrate positive employee attributes
2. The learner will be able to describe employer responsibilities

LEARNING TASKS

1. Describe positive employee attributes

CONTENT

- Communication
  - Speaking and listening
  - Use of trade language
  - Reading and comprehending
  - Writing
  - Body language
  - Customer relations

- Thinking
  - Problem-solving and decision-making
  - Use of mathematics
  - Use of current technology
  - Ability to search

- Desire to continue learning

- Positive attitude
  - Self-esteem
  - Confidence
  - Honesty and integrity
  - Initiative
  - Energy
  - Persistence
  - Cooperative

- Responsibility
  - Dependability
  - Goal and priority setting
  - Time management
  - Money management
  - Punctuality

- Adaptability
  - Positive attitude towards change
  - Respect for other diversity and differences
  - Creativity
  - Flexibility

- Team skills
  - Work with others
  - Group planning
  - Respect for others’ thoughts and opinions
  - Leadership when appropriate
  - Ability to handle conflict
2. Describe employer responsibility

- Self-control
- Care for quality
- Personal care
  - Clean
  - Neat
  - Dress appropriate
  - Rested
  - No substance abuse
- Following safety regulations
- Respect
- Trust
- Fairness
- Safe work site
- Timely payment
- Follow applicable legislation
- Provide training
Line B: PREPARE FOR EMPLOYMENT
Competency: B-3 Use Job Search Techniques

Objectives:
1. The learner will be able to prepare a resume and cover letter and save to disk
2. The learner will be able to identify job search resources
3. The learner will be able to prepare for an interview

LEARNING TASKS

1. Prepare resume
   - Gathering information
     - Goals
     - Skills
     - Education
       - Dates
     - Certification
     - Experience
       - Dates
       - Relationship and responsibilities
     - Activities
     - References
   - Statements of accomplishment
     - Challenge
     - Action
       - Skills applied
     - Results
   - Types of resumes
     - Chronological
     - Functional
     - Generic
     - Specific

2. Prepare a cover letter
   - Not to exceed one page
   - Highlight important accomplishments in same order as they appear in the posting
   - Follow-up

3. Identify job search resources
   - Newspapers
   - Internet
   - Networking
   - Industry publications
   - Direct approach

4. Prepare for an interview
   - Research the organization
   - Review of job qualifications
   - Prepare for broad personal questions
   - Review of resume
   - Interview practice
   - Personal appearance
   - Arriving ahead of time
5. Follow-up on interview

- Written
  - Letter of appreciation
- Verbal
Line C: APPLY AT WORK PRACTICES AND PROCEDURES
Competency: C-1 Use Shop Resources and Record Keeping Practices

Objectives:
1. The learner will be able to communicate using forms and reports
2. The learner will be able to use computers and written media to locate services and maintain information

LEARNING TASKS

1. Use record keeping forms
   • Types of forms
     o Work order
     o Part requisition
     o Purchase order
     o Timesheet and daily time card
     o Equipment log
     o Maintenance log
     o Maintenance schedule
     o Warranty

2. Describe the requirements for report writing
   • Types of reports
     o Service
     o Structure
     o Inclusions or attachments
     o Shift end
     o Maintenance log
     o Accident
     o Safety

3. Use of manuals
   • Service
   • Parts
   • Operators
   • Service bulletins / updates
   • Computers / Internet

4. Use computers
   • Hardware
   • Keyboard
   • Software
     o Operating systems
     o Windows
     o Managing files
     o Printing
     o Applications
     o Word processing
     o Internet access
     o E-mail
     o Online resources

5. Interpret drawings and schematics
   • Types of drawings
     o Orthographic
     o Isometric
     o Exploded views
     o Schematics
Line C: APPLY AT WORK PRACTICES AND PROCEDURES
Competency: C-2 Use Hand Tools, Power Tools and Shop Equipment

Objectives:
1. The learner will be able to select, use and maintain tools and shop equipment.
2. The learner will be held to select, use and maintain safety equipment

LEARNING TASKS

1. Use protective equipment associated with the use of tools and shop equipment
   - Personal protection
     - Head
     - Hands
     - Lungs
     - Eyes
     - Ears
     - Feet
     - Clothing
   - Screening
   - Guarding
   - Ventilation
   - Cleanup

2. Applied lockout procedures to shop equipment
   - WCB lock-out procedures
   - Electrical isolation
   - Tags
   - Locks

3. Select, use and maintain hand tools
   - Wrenches
   - Screwdrivers
   - Cutting tools
   - Hammers
   - Chisels / punches
   - Pry bars
   - Pliers
   - Clamping tools
   - Abrasives
   - Pullers
   - Torque wrenches and multipliers

4. Select, use and maintain measuring instruments
   - Layout tools
   - Precision measuring
     - Imperial
     - Metric
   - Feeler / thickness gauges

5. Select, use and maintain power tools
   - Pneumatic
   - Electric
   - Hydraulic

6. Select, use and maintain drill bits
   - Types
   - Sharpening
   - Cutting speeds
7. Select, use and maintain shop equipment

- Presses
- Parts cleaning equipment
  - Hot tank
  - Cold solution
  - Hot agitator
  - Solvent tank
  - Pressure washer
  - Steam cleaner
  - Chemical cleaners
- Drill press
- Glass beaded
- Grinders
- Compressor
- Cut-off saws
Line C: APPLY AT WORK PRACTICES AND PROCEDURES
Competency: C-3 Lift Loads

Objectives:
1. The learner will be able to apply the Occupational Health and Safety Regulation to lifting and blocking applications
2. The learner will be able to select, use and maintain lifting and blocking equipment
3. The learner will be able to lift and move loads

LEARNING TASKS

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<tr>
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<tbody>
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</table>

1. Apply the occupational health and safety regulation
   - Parts 12, 14 and 15

2. Determine load mass
   - Manufacturers’ specification
   - Estimation

3. Select, use and maintain jacks
   - Types
   - Capacities

4. Select, use and maintain stands and blocking
   - Manufacturers’ procedures
   - Types
   - Capacities
   - Bridging

5. Select, use and maintain wire ropes, chains and lifting straps
   - Types
   - Capacities
   - Rigging attachments
   - Lifting attachments

6. Used fibre rope knots, bands and hitches
   - Types
   - Uses

7. Use visual and sound signals
   - Occupational Health and Safety regulations (Part 15)

8. Select, use and maintain hoisting equipment
   - Types
   - Capacities
   - Operation

9. Lift, hoist and move loads
   - Determine safe working load
     - Manufacturers’ recommended procedures
Line C: APPLY AT WORK PRACTICES AND PROCEDURES

Competency: C-4 Use Hand Tools, Power Tools and Shop Equipment

Objectives:
1. The learner will be able to select and use imperial and metric fasteners
2. The learner will be able to select and use pipe, tubing, hoses and fittings

LEARNING TASKS

1. Select and use impartial and metric fasteners
   - Thread system
   - Fastener types
   - Washers
     - Types
     - Applications
   - Locking devices
     - Types
     - Applications

2. Cut and repair internal and external threads
   - Taps
   - Dies
   - Thread repair

3. Select and use tubing, pipe and fittings
   - Tubing
     - Types
     - Sizing
     - Applications
   - Pipe
     - Types
     - Sizing
     - Applications
   - Fitting
     - Types
     - Sizing
     - Applications
   - Sealants
   - Cutting, bending and flaring

4. Select and use hose and hose fittings
   - Hose
     - Types
     - Sizing
     - Applications
   - Pressure ratings
   - Hose end fittings
     - Types
     - Sizing
     - Applications
Line C: APPLY AT WORK PRACTICES AND PROCEDURES
Competency: C-5 Use Lubricants

Objectives:
1. The learner will be able to select and use lubricants

LEARNING TASKS

1. Describe the theory of lubricants
   - Friction
   - Purpose

2. Describe the properties of lubricants
   - Properties
     - Viscosity
     - Viscosity index
     - Additives
   - Types
     - Oils
     - Greases
     - Dry lubricants
     - Synthetics
     - Brake fluids
   - Ratings
     - American Petroleum Institute (API)
     - Society of Automotive Engineers (SAE)
     - International Organization for Standardization (ISO)
     - Multi-viscosity

3. Select and use lubricants
   - Applications
     - Oils
     - Greases
     - Dry lubricants
     - Synthetics
     - Brake fluids
   - Manufacturers' specifications
     - Minimum requirement
     - Warranty issues

4. Handle lubricants
   - Storage
   - Disposal
   - Personal protection
Line C: APPLY AT WORK PRACTICES AND PROCEDURES

Competency: C-6 Service Bearings and Seals

Objectives:
1. The learner will be able to select and service bearings and seals.

LEARNING TASKS
1. Describe Bearings
   - Types
     - Friction
     - Antifriction
   - Terminology
   - Applications
   - Loads
     - Axial
     - Radial
2. Select and service Bearings
   - Installation
     - Procedures
     - Lubrication
3. Describe seals
   - Types
     - Static
     - Dynamic
   - Applications
4. Select and service seals
   - Installation
     - Procedure
     - Sleeves
     - Lubrication
   - Removal
   - Failure analysis
Line C: APPLY AT WORK PRACTICES AND PROCEDURES

Competency: C-7 Use Oxy-Fuel and Shielded Metal Arc Welding Equipment

Objectives:
1. The learner will be able to identify metals
2. The learner will be able to describe different welding procedures
3. The learner will be able to cut, weld and brace using oxy-acetylene
4. The learner will be able to use shielded metal arc weld
5. The learner will be able to weld using wire feed processes
6. The learner will be able to solder tubing and sheet metal

LEARNING TASKS

1. Identify regulations with respect to welding
   - Occupational Health and Safety regulations
     - 12.112 cutting welding and applied processes
     - Can/CSA W117.2-01

2. Identify metals
   - Metals and alloys
   - Terminology
   - Shapes
   - Storage and handling

3. Identify oxy-acetylene components
   - Gases
   - Valves and regulators
   - Cylinders
   - Hoses and fittings
   - Safety precautions
   - Blow back
   - Check valve

4. Use oxy-acetylene equipment
   - Assembly procedures
   - Operation procedures
     - Lighting
     - Adjusting
     - Shutting down
   - Leak testing

5. Cut mild steel with oxy-acetylene equipment
   - Set up
   - Freehand cuts
   - Guided cuts
   - Hole piercing

6. Weld mild steel with oxy-acetylene equipment
   - Fusion
   - Weld
   - Joints
     - Corner
     - Butt
     - Lap
     - Tee

7. Braze lap joints with oxy-acetylene equipment
   - Brazing set up
   - Brazing techniques
8. Solder tubing and sheet metal
   - Process and procedures
     - Tubing
     - Sheet metal

9. Describe the shielded metal arc welding (SMAW) process
   - Process
   - Safety requirements

10. Identify shielded metal arc welding equipment
    - AC/DC machines
    - Components
    - Electrode holder
    - Ground clamps
    - Cables
    - Connectors

11. Identify mild steel electrodes for shielded metal arc welding
    - Types
    - Operations
    - Classifications
    - Selection
    - Storage and handling

12. Weld mild steel with shielded metal arc
    - Procedures
    - Ground placement to avoid bearing and component arcing damage
    - Procedures to avoid electronic component damage
    - Settings
    - Positions
    - Joints
    - Fillet welds

13. Weld mild steel using wire feed processes
    - Procedures
    - Settings
    - Welds

14. Describe air-arc gouging
    - Purpose
    - Procedure
Line C: APPLY AT WORK PRACTICES AND PROCEDURES

Competency: C-8 Operate Equipment

Objectives:
1. The learner will be able to perform pre-start and walk around inspections
2. The learner will be able to start, move, secure and stop equipment
3. The learner will obtain a valid forklift operation certificate

LEARNING TASKS

1. Describe pre-start and walk around inspections
   - Checklist
   - Operator’s manuals

2. Describe starting aids
   - Glow plug system
   - Intake preheater system
   - Starting fluids
   - Block/circulating heaters
   - Battery warmers

3. Describe start up procedures
   - Controls
   - Cranking
   - Monitoring
   - Jump starting

4. Describe emergency shutdown procedures
   - Cut off
     - Fuel
     - Air
     - Compression

5. Start, operate and shut down selected equipment
   - Pre-start and walk around
   - Use of starting aids
   - Moving
   - Securing and shutting down

6. Lock-out heavy duty equipment prior to service
   - WCB requirements
   - Electrical isolation
   - Tag
   - Key in pocket

7. Operate a forklift
   - Obtain forklift certificate
   - Meets Occupational Health and Safety regulations
**Program Content**
**ELTT (Module 1)**

**Line C:** APPLY AT WORK PRACTICES AND PROCEDURES  
**Competency:** C-9 Describe Diagnostic Procedures

**Objectives:**
1. The learner will be able to describe the importance of following a diagnostic process  
2. The learner will be able to describe diagnostic procedures used for troubleshooting

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>LEARNING TASK</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe the importance of following a diagnostic process | • Cost of improper diagnosis  
• Unhappy customers  
• Lost business  
• Time management  
• Efficiency  
• Damage to components |
| 2. Describe general diagnostic procedures | • Understand system  
• Understand complaint  
  o Communicate with operator  
  o Operational test  
  o Visual inspection  
• Form all possible conclusions  
• Test conclusions  
• System component isolation |
| 3. Describe the importance of following manufacturers’ diagnostic procedures where available | • Time saving  
• Warranty requirement  
• Diagnosis may not be possible any other way |
| 4. Describe the importance of failure analysis | • Repeat failure  
• Extended life  
• Cost  
• Customer satisfaction |
Line C: APPLY AT WORK PRACTICES AND PROCEDURES

Competency: C-9 Describe Diagnostic Procedures

Objectives:
1. The learner will be able to describe the importance of following a diagnostic process
2. The learner will be able to describe diagnostic procedures used for troubleshooting

LEARNING TASKS

1. Describe the importance of following a diagnostic process
   - Cost of improper diagnosis
   - Unhappy customer
   - Lost business
   - Time management
   - Efficiency
   - Damage to components

2. Describe general diagnostic procedures
   - WCB lock-out procedures
   - Electrical isolation
   - Tags
   - Locks

3. Select, use and maintain hand tools
   - Wrenches
   - Screwdrivers
   - Cutting tools
   - Hammers
   - Chisels / punches
   - Pry bars
   - Pliers
   - Clamping tools
   - Abrasives
   - Pullers
   - Torque wrenches and multipliers

4. Select, use and maintain measuring instruments
   - Layout tools
   - Precision measuring
     - Imperial
     - Metric
   - Feeler / thickness gauges

5. Select, use and maintain power tools
   - Pneumatic
   - Electric
   - Hydraulic

6. Select, use and maintain drill bits
   - Types
   - Sharpening
   - Cutting speeds
7. Select, use and maintain shop equipment

- Presses
- Parts cleaning equipment
  - Hot tank
  - Cold solution
  - Hot agitator
  - Solvent tank
  - Pressure washer
  - Steam cleaner
  - Chemical cleaners
- Drill press
- Glass beaded
- Grinders
- Compressor
- Cut-off saws
Line D: SERVICE WHEELED EQUIPMENT AND ATTACHMENTS
Competency: D-1 Service Tires, Wheels and Hubs

Objectives:
1. The learner will be able to describe and service tires and rims
2. The learner will be able to describe and service wheels and hubs
3. The learner will be able to describe traction control devices

LEARNING TASKS

1. Describe tires and rims
   - Types of tires
   - Types of rims
   - Mounting types
   - Hardware

2. Troubleshoot tires and rims
   - Road test
   - Inspections
     - Tire wear
     - Wheel run out
     - Air pressure
   - Measuring

3. Service tires and rims
   - Safety precautions
   - Inspection
   - Repair or replace
   - Matching
   - Mounting
     - Torquing and retorquing
   - Balancing
     - Static
     - Dynamic
     - Stationary
     - Portable
   - Scheduled maintenance

4. Describe wheels and hubs
   - Types
     - Conventional
     - Planetary
   - Components
   - Bearings
   - Seals
   - Lubrication

5. Troubleshoot wheels and hubs
   - Road test
   - Inspection
   - Testing

6. Service wheels and hubs
   - Inspection
   - Replacements
   - Repair
   - Adjustment
   - Lubrication
   - Scheduled maintenance
7. Describe traction devices

- Types
  - Chains
  - Sanders
- Components
- Operation
Line D: SERVICE WHEELED EQUIPMENT AND ATTACHMENTS
Competency: D-2 Service Frames

Objectives:
1. The learner will be able to describe types of frames
2. The learner will be able to troubleshoot and service frames

LEARNING TASKS

1. Describe types of frames
   - Trucks
   - Rigid
   - Articulated
   - Components
   - Operation

2. Troubleshoot frames
   - Components
   - Visual inspection
   - Alignment
     o Measurement

3. Service frames
   - Visual inspection
   - Repair or replace
   - Adjustment
   - Alignment
   - Scheduled maintenance
Program Content
ELTT (Module 1)

Line D: SERVICE WHEELED EQUIPMENT AND ATTACHMENTS
Competency: D-3 Service Suspension Systems

Objectives:
1. The learner will be able to describe wheel machine suspension systems
2. The learner will be able to troubleshoot and service wheel machine suspension systems

LEARNING TASKS

1. Describe suspension systems
   - Types
     - Spring
     - Equalizer beam
     - Air spring
     - Rubber pad or cushion
     - Hydro pneumatic
   - Components
   - Operation

2. Troubleshoot suspension systems
   - Road test
   - Components
   - Inspection
   - Measuring

3. Service suspension systems
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Scheduled maintenance
Line D: SERVICE WHEELED EQUIPMENT AND ATTACHMENTS
Competency: D-4 Service Steering Systems

Objectives:
1. The learner will be able to describe wheel machines steering systems
2. The learner will be able to troubleshoot and service wheel machine steering systems

LEARNING TASKS
1. Describe steering systems
   CONTENT
   • Types
     ○ Steering axle
     ○ Front/rear wheel combinations
     ○ Articulated
     ○ Skids

2. Troubleshoot steering systems
   • Road test
   • Components
   • Inspection
   • Testing

3. Service steering systems
   • Inspection
   • Remove
   • Repair or replace
   • Install
   • Adjustments
   • Lubrication
   • Testing
   • Scheduled maintenance
Program Content
ELTT (Module 1)

Line D: SERVICE WHEELED EQUIPMENT AND ATTACHMENTS
Competency: D-5 Service Working Attachments

Objectives:
1. The learner will be able to describe wheel machine working attachments
2. The learner will be able to troubleshoot and service wheel machine working attachments

LEARNING TASKS

1. Describe working attachments

   • Types
     o Blades and frames
     o Buckets
     o Booms and arms
     o Rippers and arms
     o Cylinders
     o Tampers
     o Rock breaker
     o Grapple

   • Components
   • Operation

2. Troubleshoot working attachments

   • Operational test
   • Diagnostic codes
   • Components
   • Inspection
   • Testing

3. Service working attachments

   • Inspection
   • Remove
   • Repair or replace
   • Install
   • Adjustments
   • Lubrication
   • Testing
   • Diagnostic codes
   • Scheduled maintenance
Line E: SERVICE TRACK MACHINES AND ATTACHMENTS
Competency: E-1 Service Undercarriage

Objectives:
1. The learner will be able to describe track machine undercarriages
2. The learner will be able to troubleshoot and service track machine undercarriages

LEARNING TASKS

1. Describe undercarriages
   - Types
     - Excavator
     - Crawler, Dozer/Loader
     - Crane
     - Tank
     - Tank drill
     - Crawler crane
     - Shovel
   - Components
   - Operation

2. Troubleshoot undercarriages
   - Operational test
   - Components
   - Inspection
   - Measuring

3. Service undercarriages
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
Line E: SERVICE TRACK MACHINES AND ATTACHMENTS
Competency: E-2 Service Final Drives

Objectives:
1. The learner will be able to describe track machine final drives
2. The learner will be able to troubleshoot and service track machine final drives

LEARNING TASKS

1. Describe final drives
   - Types
     - Single reduction
     - Double reduction
     - Planetary
     - Hydrostatic drive
   - Components
   - Operation
     - Gear reduction theory

2. Troubleshoot final drives
   - Operational test
   - Components
   - Inspection
   - Testing

3. Service final drives
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
Line E: SERVICE TRACK MACHINES AND ATTACHMENTS
Competency: E-3 Service Steering Systems

Objectives:
1. The learner will be able to describe track machine steering systems
2. The learner will be able to troubleshoot and service selected track machine steering systems

LEARNING TASKS

1. Describe steering systems
   - Types
     - Steering clutch
     - Planetary
     - Hydrostatic
     - Differential
   - Components
   - Operation

2. Troubleshoot steering systems
   - Operational test
   - Components
   - Inspection
   - Testing
     - Excluding hydrostatics

3. Service undercarriages
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
     - Excluding hydrostatics
   - Scheduled maintenance
Line E: SERVICE TRACK MACHINES AND ATTACHMENTS
Competency: E-4 Service Working Attachments

Objectives:
1. The learner will be able to describe track machine working attachments
2. The learner will be able to troubleshoot and service track machine working attachments

LEARNING TASKS

1. Describe working attachments
   - Types
     - Blades
     - Buckets
     - Rippers
     - Grapple
     - Saw head
     - Processor
   - Components
   - Operation
     - Diagnostic codes

2. Troubleshoot working attachments
   - Operational test
   - Components
   - Inspection

3. Service working attachments
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
Line F: SERVICE WIRE ROPE AND WINCHES
Competency: F-1 Service Wire Ropes

Objectives:
1. The learner will be able to describe wire rope and its applications
2. The learner will be able to inspect and service wire rope used on winches

LEARNING TASKS

1. Describe wire rope
   - Types
     - Construction
   - Application
     - Safe working load
   - Selection criteria

2. Inspect wire rope
   - Frequency
   - Wear
   - Damage
   - Kinks

3. Service wire rope
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Scheduled maintenance
Line F: SERVICE WIRE ROPE AND WINCHES
Competency: F-2 Service Winches

Objectives:
1. The learner will be able to describe tractor mounted and hoist winches
2. The learner will be able to troubleshoot and service winches

LEARNING TASKS

1. Describe winches
   - Types
     - Tractor mounted
     - Hoist
     - Mechanical
     - Electrical
     - Hydraulic
   - Components
   - Operation

2. Troubleshoot winches
   - Operational test
   - Components
   - Inspection
   - Testing
     - Mechanical
     - Hydraulic

3. Service winches
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
Line G: SERVICE HYDRAULIC SYSTEMS
Competency: G-1 Describe Hydraulic Systems

Objectives:
1. The learner will be able to describe the principles of hydraulics
2. The learner will be able to describe the basic components of a hydraulic system
3. The learner will be able to describe the types of hydraulic systems

LEARNING TASKS

1. Describe the principles of hydraulics
   - Fluid characteristics
   - Pascal's Law
   - Calculations
     - Imperial
     - Metric
     - Force
     - Pressure
     - Area
     - Hydraulic power ratings
   - Bernoulli's Principle
   - Terminology
   - Advantages/disadvantages

2. Describe the basic operation of a hydraulic system
   - Components
     - Reservoir
     - Pump
     - Actuator
     - Control valves
     - Connecting lines
     - Fluid

3. Describe types of hydraulic systems
   - Open centre
   - Closed centre
   - Open loop
   - Closed loop
   - Pressurized
   - Vented
   - Introduction to load sensing
Line G: SERVICE HYDRAULIC SYSTEMS  
Competency: G-2 Service Hydraulic Systems

Objectives:
1. The learner will be able to describe selected hydraulic components.
2. The learner will be able to select hydraulic fluids for application.
3. The learner will be able to select and assemble hydraulic hoses and fittings.
4. The learner will be able to demonstrate safe work procedures for hydraulic system service.
5. The learner will be able to perform scheduled maintenance on hydraulic systems.

LEARNING TASKS

1. Describe hydraulic components
   - Seals
   - Hoses/lines
   - Fittings
   - Filters

2. Select hydraulic fluids
   - Requirements
     - Manufacturers’ specifications
     - API service ratings
     - SAE viscosity ratings
   - Synthetic/Non-synthetic (minerals)
     - Component compatibility

3. Select hydraulic hoses and fittings
   - Hose construction
   - Hose application
     - Working pressures
     - Flow rates
     - Compatibility
   - Fitting types
   - Joint Industry Council (JIC)
   - Society of Automotive Engineers
   - National Pipe Thread (NPT)
   - O-rings
   - Reusable/Permanent
   - Hose compatibility

4. Assemble hydraulic hoses and fittings
   - Permanent
   - Reusable
   - Skive/no skive

5. Demonstrate safe work procedures
   - Safety blocking equipment and attachments
   - Relieve pressure
     - Reservoir venting
     - Actuator neutralization
   - Temperature hazards
6. Perform scheduled maintenance

- Visual inspection
  - Leaks
  - Hose rubs
  - External damage
- Fluid level check
- Filter change
- Fluid change
- Fluid analysis
Line H: SERVICE HYDRAULIC BRAKE SYSTEMS

Competency: H-1 Describe Hydraulic Brake Systems

Objectives:
1. The learner will be able to describe the principles of braking
2. The learner will be able to describe the construction and operation of foundation brakes
3. The learner will be able to describe the construction and operation of brake system hydraulics
4. The learner will be able to select hydraulic brake fluids
5. The learner will be able to describe the construction and operation of parking brakes

LEARNING TASKS

1. Describe the principles of braking
   - Friction
     o Definition
     o Coefficient
   - Heat
     o Absorbing
     o Dissipating
   - Effects of speed and weight
   - Brake fade

2. Describe the foundation Brake
   - Types
     o Disk
     o Drum
   - Components
   - Operation
     o Self energizing and non-self energizing
     o Servo/non-servo

3. Review hydraulic principles
   - Pressure, force and area

4. Describe the hydraulics of a brake system
   - Types
     o Disk
     o Drum
   - Components
   - Operation

5. Select brake fluids
   - Requirements
   - Characteristics
   - Identification

6. Describe parking brake systems
   - Types
   - Components
   - Operation
Line H: SERVICE HYDRAULIC BRAKE SYSTEMS
Competency: H-2 Service Hydraulic Brake Systems

Objectives:
1. The learner will be able to perform preventive maintenance on hydraulic brake systems

LEARNING TASKS
1. Perform preventive maintenance

CONTENT
- Inspection
- Operational tests
- Fluid level checks
- Adjustment
- Lubrication
**Line H:** SERVICE HYDRAULIC BRAKE SYSTEMS  
**Competency:** H-3 Service Hydraulic Brake Systems

**Objectives:**
1. The learner will be able to describe power brake systems  
2. The learner will be able to perform preventive maintenance on power brake systems

**LEARNING TASKS**

<table>
<thead>
<tr>
<th></th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Describe the power brake systems</td>
</tr>
<tr>
<td></td>
<td>• Types</td>
</tr>
</tbody>
</table>
|   | • Vacuum boosters  
|   |   o Hydro-boost  
|   |   o Hydro-max |
|   | • Components |
|   | • Operation |
| 2. | Perform preventive maintenance on power brake systems |
|   | • Inspection |
|   | • Operational check |
Line I: SERVICE AIR BRAKE SYSTEMS

Competency: I-1 Service Air Brake Systems

Objectives:
1. The learner will be able to describe the principles of braking
2. The learner will be able to describe the principles of pneumatics
3. The learner will be able to describe air brake schedules and their components
4. The learner will be able to service limited air brake systems and their components
5. The learner will be able to rebuild a wheel brake assembly
6. The learner will be able to describe and perform a pre-trip inspection
The learner will be encouraged to obtain an air brake endorsement on their driver’s license.

LEARNING TASKS

1. Describe the principles of braking
   - Friction
     - Definition
     - Coefficient
   - Heat
     - Absorbing
     - Dissipating
   - Effects of speed and weight
   - Brake fade
   - Water cooling

2. Describe the principles of pneumatics
   - Characteristics of air
   - Relationship between force, pressure and area
   - Effects of heat on air

3. Describe a basic air brake system
   - Sub systems
     - Supply
     - Delivery
     - Foundation brakes
   - Components
   - Operation

4. Describe tractor air brake schedules and their components
   - 121
   - BT-75
   - T-75
   - L-75

5. Describe trailer air brake schedules and their components
   - 121 trailer
   - S
   - SX
   - Converted dollies

6. Rebuild wheel brake assembly
   - Inspection
   - Disassembly
   - Measurement
   - Assembly
   - Adjustment
7. Service air brake components
   - Tractor and trailer
   - Inspection
   - Adjustment
   - Scheduled maintenance

8. Describe pre-trip brake inspections
   - As per Motor Vehicle Standards Act

9. Perform a pre-trip brake inspection
   - As per Motor Vehicle Standards Act
Line J: SERVICE ALTERNATIVE BRAKE SYSTEMS
Competency: J-1 Describe Dynamic Brake Systems

Objectives:
1. The learner will be able to describe the construction and operation of various dynamic brake systems

LEARNING TASKS
1. Describe dynamic brake systems

CONTENT
- Types
  - Hydraulic retarder
  - Electric retarder
  - Engine brake
  - Exhaust brake
- Construction
- Operation
Line J: SERVICE ALTERNATIVE BRAKE SYSTEMS
Competency: J-2 Service Expanding Tube Type Brakes

Objectives:
1. The learner will be able to describe the construction and operation of expanding tube brakes

LEARNING TASKS
CONTENT
1. Describe expanding tube type brakes
   • Construction
   • Operation
Line J: SERVICE ALTERNATIVE BRAKE SYSTEMS
Competency: J-3 Service Multi-Disc Brake Systems

Objectives:
1. The learner will be able to describe the construction and operation of multi-disc brake systems

LEARNING TASKS
1. Describe multi-disc brake systems

CONTENT
• Construction
• Operation
Line (K): SERVICE AIR OPERATED SYSTEMS
Competency: K-1 Service Industrial Compressors and Components

Objectives:
1. The learner will be able to describe the construction and operation of industrial air compressors
2. The learner will be able to troubleshoot and service industrial air compressors

LEARNING TASKS
1. Describe industrial air compressors
   - Types
     - Reciprocating
     - Rotary Vane
     - Rotary screw
   - Components
   - Operation

2. Troubleshoot industrial air compressors
   - Operational test
   - Components
   - Inspection
   - Testing

3. Service industrial air compressors
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustment
   - Lubrication
   - Testing
   - Scheduled maintenance
Line L: SERVICE DIESEL ENGINES

Competency: L-1 Describe the Theory of Internal Combustion Engines

Objectives:
1. The learner will be able to describe the combustion process
2. The learner will be able to describe terminology and perform calculations related to engines
3. The learner will be able to describe the principles of operation of two and four stroke cycle internal combustion engines

LEARNING TASKS

1. Describe the combustion process
   - Composition of air
   - Composition of fossil fuels
   - Requirements for combustion
     - Combining air, fuel and heat
   - Heat value and energy of fuel
   - By-products of combustion

2. Describe terminology and perform calculations related to engines
   - Concepts of
     - Work
     - Energy
       - Heat
       - BTU's
       - Joules
     - Inertia
     - Friction
     - Power
       - Kilowatts
       - Horsepower
     - Bore and stroke
     - Displacement
     - Compression ratio
     - Torque
     - Volumetric efficiency
   - Metric and Imperial formulae for
     - Power
       - Kilowatts
       - Horsepower
       - Bore and stroke
       - Displacement
       - Compression ratio
       - Torque

3. Describe internal combustion engine classification
   - Fuel
   - Cooling
   - Ignition
   - Number of cylinders
   - Firing order
   - Cycle type
   - Cylinder configuration
   - Aspiration
4. Describe the operation of four stroke internal combustion engines

5. Describe the operation of two stroke internal combustion engines

- Rotation
- Intake
- Compression
- Power
- Exhaust
- Timing
- Valve overlap
- Relative cycle times
- Intake
- Compression
- Power
- Exhaust
- Timing
- Relative cycle times
- Scavenging
Line L: SERVICE DIESEL ENGINES
Competency: L-2 Remove and Install Diesel Engines

Objectives:
1. The learner will be able to describe the preparation prior to diesel engine removal
2. The learner will be able to remove and install a diesel engine

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe the procedures to prepare a diesel engine for removal | • Cleaning  
• Disconnect batteries  
• Precautions  
  o Electronic devices  
  o Environmental  
  o Fuel/oil lines  
  o Air conditioning  
  o Coolant  
• Tag before removing all  
  o Oil lines  
  o Air lines  
  o Wiring  
• Note location of all accessories and attachments  
| 2. Remove engine | • Follow manufacturers’ recommendations  
• Secure machine  
• Use the proper engine lifting brackets  
• Support or remove transmission  
• Use the proper jacks, supports and lifting devices  
• Make use of an assistant during removal  
• Secure engine after removal  
| 3. Install engine | • Follow the manufacturers’ recommendations  
• Use the proper engine lifting brackets  
• Reinstall transmission  
• Connect engine to support systems  
• Refill fluids to specifications  
• Perform checks/tests  
• Recheck levels/adjustments |
Line L: SERVICE DIESEL ENGINES
Competency: L-4 Service Engine Support Systems

Objectives:
1. The learner will be able to describe engine support systems
2. The learner will be able to perform preventive maintenance on engine support systems

LEARNING TASKS
1. Describe engine support systems
   - Cooling
   - Lubricant
   - Air induction
   - Exhaust
   - Fuel

2. Service cooling systems
   - Inspection
   - Coolant
     - Freeze point
     - PH level
   - Filters
   - Scheduled maintenance

3. Service lubrication systems
   - Inspection
   - Lubricants
   - Filters
   - Scheduled maintenance

4. Service air induction systems
   - Inspection
   - Aspirators
   - Filters
   - Scheduled maintenance
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-1 Describe Basic Principles of Electricity

Objectives:
1. The learner will be able to define electrical terminology
2. The learner will be able to explain basic circuit concepts
3. The learner will be able to perform circuit calculations
4. The learner will be able to describe magnetic theory

LEARNING TASKS

1. Describe electrical terminology
   - Electrical quantities and their units and prefixes
     - Voltage
     - Current
     - Resistance
     - Power
   - Circuit terminology
     - Open circuit
     - Closed circuit
     - Short circuit
     - Continuity
     - Ground
     - Ground fault
     - Series circuit
     - Parallel circuit
     - Series parallel circuit

2. Explain basic circuit concepts and perform calculations
   - Sources of electricity
   - Atomic theory
     - Current flow
     - Conductors
     - Insulators
     - Semiconductors
   - Basic circuit
     - Source
     - Load
     - Complete path
   - Electrical relationships
     - Ohm’s law
     - Watts law (P=ExI)
     - Series circuit
     - Parallel circuits
     - Series parallel circuits
3. Describe magnetic theory

- Properties of magnetic lines of force
- Terminology
  - Flux
  - Flux density
  - Reluctance
- Relationship to electric current
  - Left hand rule for conductors
  - Left hand rule for coils
  - Electromagnetic induction
    - Types
    - Requirements
    - Factors affecting magnitude
- Effect of magnetic core on coils
- Concept of signal interference
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-2 Identify Common Electrical and Electronic Components

Objectives:
1. The learner will be able to identify common electrical and electronic components
2. The learner will be able to interpret wiring diagrams and symbols

LEARNING TASKS
1. Identify common electrical components
   - Lamps
   - Switches
   - Relays
   - Solenoids
   - Resistors
     - Fixed
     - Variable
   - Capacitors
   - Motors
   - Alternators
   - Fuses

2. Describe the function of common electronic components
   - Semiconductors
     - Diodes
       - Standard only
     - Transistors

3. Interpret basic electrical wiring diagrams
   - Types of diagrams
   - Symbols
   - Conventions
   - Abbreviations
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-3 Use Electrical Testing Instruments

Objectives:
1. The learner will be able to use electrical measuring devices

LEARNING TASKS
1. Describe how to use electrical measuring devices
   - Analog vs. digital
   - Voltmeters
   - Ammeters
   - Ohmmeters
   - Multimeters (VOM)
   - VAT’s (Volt amp testers)
   - Continuity testers
   - Test lights
   - Safety precautions

2. Use electrical measuring devices
   - Voltage drops
   - Shorts
   - Grounds
   - Opens
   - Circuit loads
**Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS**

**Competency:** M-4 Service Electrical/Electronic Circuits

**Objectives:**
1. The learner will be able to test and repair limited electrical and electronic circuit faults

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>Task</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Replace electrical components</td>
<td>Lamps</td>
</tr>
<tr>
<td></td>
<td>Starters</td>
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<tr>
<td></td>
<td>Alternators</td>
</tr>
<tr>
<td></td>
<td>Batteries</td>
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<tr>
<td></td>
<td>Switches</td>
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<tr>
<td></td>
<td>Motors</td>
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<td></td>
<td>Fuses</td>
</tr>
<tr>
<td>2. Select conductors and install terminators</td>
<td>Wire gauge/ampacity</td>
</tr>
<tr>
<td></td>
<td>Connector types</td>
</tr>
<tr>
<td>3. Diagnose circuit faults</td>
<td>Voltage drops</td>
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<td>Shorts</td>
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<td>Opens</td>
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<td></td>
<td>High resistance</td>
</tr>
<tr>
<td></td>
<td>Use circuit diagrams</td>
</tr>
</tbody>
</table>
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: M-5 Service Batteries

Objectives:
1. The learner will be able to describe battery design and operations
2. The learner will be able to select, test and maintain batteries
3. The learner will be able to diagnose causes of battery failure
4. The learner will be able to remove and replace batteries

LEARNING TASKS

1. Describe safety considerations when working with batteries
   - Personal protection
   - Hydrogen gassing
   - Acid
   - Frozen batteries
   - Short circuit capacity (arching)
   - Environmental considerations

2. Describe the design and construction of a lead acid battery
   - Plates
   - Plate straps
   - Separators
   - Electrolyte
   - Case
   - Terminals

3. Describe the chemical action that takes place in a lead acid battery during charging and discharging
   - Charging cycle
   - Discharging cycle

4. Describe the various types of batteries
   - Low maintenance
   - Maintenance free
   - Deep-cycle
   - Recombination
   - Gel cell

5. Select batteries
   - Battery rating methods
   - Physical dimensions

6. Maintain batteries
   - Safety precautions
   - Factors affecting the life cycle of batteries
   - Inspection
   - Cleaning
   - Terminal servicing
   - Charging
   - Replacement
   - Scheduled maintenance
   - Storage and handling

7. Test batteries
   - Specific gravity
   - Open circuit voltage test
   - Load test
   - 3 minute fast charge test
8. Use booster batteries

- Safety
- Voltage
  - 12
  - 24
  - 12/24
- Polarity
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-6 Service Starting Systems

Objectives:
1. The learner will be able to identify starting system components
2. The learner will be able to describe the design and operation of starting systems
3. The learner will be able to perform maintenance on starting systems

LEARNING TASKS

1. Identify components of starting systems
   - Battery
   - Starter motor assembly
   - Solenoids and relays
   - Ring gear
   - Ignition switch
   - Neutral safety switch/clutch pedal switch
   - Cables and terminals
   - Anti-theft devices

2. Describe the design and operation of starting systems
   - System voltage
   - 12 volt
   - 24 volt
   - 12/24 volt
   - Battery configuration
   - Isolation switches
   - Starter motor assembly
   - Solenoids and relays
   - Ring gear
   - Ignition switch
   - Neutral safety switch/clutch pedal switch
   - Cables and terminals

3. Inspect and repair starting systems
   - Inspection
     - Visual
     - Audible
   - Routine maintenance
   - Component removal and replacement
Line M: SERVICE ELECTRICAL AND ELECTRIC SYSTEMS
Competency: M-7 Service Charging Systems

Objectives:
1. The learner will be able to describe the purpose of a charging system
2. The learner will be able to perform routine maintenance on a charging system

LEARNING TASKS

1. Describe charging systems
   - Purpose
   - Alternator assembly

2. Maintain charging systems
   - Inspection
   - Visual
   - Audible
   - Output voltage test
   - Belt condition and tension
   - Component removal and replacement
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-1 Service Gasoline Fuel Systems

Objectives:
1. The learner will be able to describe the characteristics of gasoline
2. The learner will be able to identify components of a gasoline fuel system
3. The learner will be able to perform limited maintenance on gasoline fuel systems

LEARNING TASKS
1. Describe the characteristics of gasoline

2. Identify the components that make up a gasoline fuel system

3. Maintain gasoline fuel systems

CONTENT
- Physical properties
- Heat value
- Octane
- Storage considerations
- Supply section
- Delivery section
- Carbureted
- Fuel injected
- Filter change
- Fuel transfer pump replacement
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-2 Describe Propane Fuel Systems

Objectives:
1. The learner will be able to describe the characteristics of liquefied petroleum gas
2. The learner will be able to identify the components of an LPG system

LEARNING TASKS
1. Describe the characteristics of liquefied petroleum gas (LPG)
2. Identify the components that make up an LPG fuel system

CONTENT
- Physical properties
- Heat value
- Octane
- Storage considerations
- Supply section
- Delivery section
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-3 Describe Natural Gas Fuel Systems

Objectives:
1. The learner will be able to describe the characteristics of compressed natural gas.
2. The learner will be able to identify the components of a CNG system.

LEARNING TASKS
1. Describe the characteristics of compressed natural gas (CNG):
   - Physical properties
   - Heat value
   - Octane
   - Storage considerations

2. Identify the components that make up a CNG fuel system:
   - Supply section
   - Delivery section
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-4 Service Ignition Systems

Objectives:
1. The learner will be able to identify the components of ignition systems
2. The learner will be able to maintain ignition systems

LEARNING TASKS

1. Describe components of ignition systems
   • Distributor assembly
   • Ignition coil(s)
   • Ballast resistor
   • High tension leads
   • Spark plugs
   • Ignition switch
   • Sensors
   • Ignition module
   • Electronic control module (ECM)

2. Maintain ignition systems
   • Timing
   • Spark plug replacements
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-1 Describe the Principles of Diesel Fuel Injection

Objectives:
1. The learner will be able to describe characteristics of diesel fuel

LEARNING TASKS
1. Describe characteristics of diesel fuel

CONTENT
- Grades
- Characteristics
  - Viscosity
  - Cetane
    - Rating
    - Number
  - Flash point
  - Sulfur content
  - Distillation
  - Summer/winter fuel
  - API gravity
- Storage
- Disposal
- Safety precautions
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-2 Service Fuel Supply Circuits

Objectives:
1. The learner will be able to describe diesel fuel supply circuits and their components
2. The learner will be able to perform limited service on diesel supply circuits

LEARNING TASKS
1. Describe diesel fuel supply circuits
   - Types
   - Components
   - Water separators
   - Filters
   - Transfer pumps
   - Tank
   - Operation
2. Service diesel fuel supply circuits
   - Inspection
   - Filter replacements
   - Priming
   - Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-1 Describe Power Transfer Systems

Objectives:
1. The learner will be able to describe methods of transferring power
2. The learner will be able to describe the principles of power transfer

LEARNING TASKS

1. Describe methods of transferring power
   - Fluids
   - Shafts
   - Belts
   - Chains
   - Gears

2. Describe the principles of power transfer
   - Gear ratios
     - Simple
     - Compounds
   - Torque
   - Speed
   - Power flow
     - Truck
     - Crawler
     - Excavator
     - Loader
   - Gear types
Program Content
ELTT (Module 1)

Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-2 Service Clutches

Objectives:
1. The learner will be able to describe the principles and operation of clutches and related components
2. The learner will be able to service clutches and related components

LEARNING TASKS

1. Describe principles and operation of clutches and related components
   - Friction
   - Types
     - Friction
       - Wet/dry
       - Single/multi-plate
     - Mechanical
       - Jaw
       - Magnetic
   - Components
   - Operation

2. Service clutches and related components
   - Inspection
     - Visual
       - Linkage wear
       - Heat damage
     - Measure
       - Wear
       - Flywheel and housing run-out
   - Troubleshooting
     - Operational checks
   - Removal
   - Replacement
   - Adjustments
   - Lubrication
   - Scheduled maintenance

CONTENT
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-3 Service Standard Transmissions

Objectives:
1. The learner will be able to describe the operation of standard transmissions
2. The learner will be able to perform limited service on standard transmissions

LEARNING TASKS
1. Describe the principles and operation of standard transmissions

CONTENT
• Types
• Components
• Operation
• Lubrication

2. Service standard transmissions

• Visual inspections
  o Fluid levels
  o Leaks
  o Mounting of attachments
• Removal
• Installation
• Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-4 Service Drive Lines

Objectives:
1. The learner will be able to describe drive lines and their components
2. The learner will be able to service drive lines and their components

LEARNING TASKS
1. Describe drive lines and components
2. Service drive lines and components

CONTENT
- Types
- Components
- Operation
- Phasing
- Alignment
- Inspection
- Removal
- Replacement
- Lubrication
- Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-5 Service Drive Axles

Objectives:
1. The learner will be able to describe the principles and operation of drive axles
2. The learner will be able to perform limited service on drive axles

LEARNING TASKS

1. Describe the principles and operation of drive axles
   - Types
     - Single axles
     - Tandem axles
     - Tridem axles
   - Components
     - Differentials
     - Axle shafts
     - Traction devices
     - Inter axle differentials
   - Mountings
   - Operation
   - Lubrication

2. Service drive axles
   - Check operations
   - Visual inspections
     - Fluid levels
     - Leaks
     - Mountings of attachments
   - Scheduled maintenance
   - Remove
   - Install
Objectives:
1. The learner will be able to describe the operation of machine final drives and hubs
2. The learner will be able to service wheel machine final drives

LEARNING TASKS
1. Describe operation of wheel machine final drives and hubs
2. Service wheel machine final drives

CONTENT
- Types
- Components
- Operation
- Inspection
- Remove
- Repair or replace
- Install
- Adjustments
- Lubrication
- Operational test
- Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-7 Service Torque Converters/Dividers

Objectives:
1. The learner will be able to describe the purpose of torque converters and dividers
2. The learner will be able to perform limited service on torque converters and dividers

LEARNING TASKS
1. Describe the purpose of torque converters/dividers

2. Service torque converters/dividers

CONTENT
- Types
- Components
- Fluids
- Check operation
- Visual inspections
  - Fluid levels
  - Leaks
  - Mounting of attachments
- Removal
- Installation
- Filters/screens
- Oil coolers
- Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-8 Service Power Shift and Automatic Transmissions

Objectives:
1. The learner will be able to describe the basic operation of power shift and automatic transmissions
2. The learner will be able to perform limited service on power shift and automatic transmissions

LEARNING TASKS
1. Describe the basic operation of power shift and automatic transmissions
2. Service power shift and automatic transmissions

CONTENT
• Types
• Construction
• Operation
• Inspection
• Remove
• Install
• Adjustments
• Fluid level
• Operational testing
• Scheduled maintenance
Level 1

Heavy Duty Equipment Mechanic
Line C: APPLY WORK PRACTICES AND PROCEDURES

Competency: C-9 Describe Diagnostic Procedures

Objectives
1. The learner will be able to describe the importance of following a diagnostic process
2. The learner will be able to describe diagnostic procedures used for troubleshooting

LEARNING TASKS

1. Review the importance of following a diagnostic process
   - Cost of improper diagnosis
   - Unhappy customer
   - Lost business
   - Time management
   - Efficiency
   - Damage to components

2. Review general diagnostic procedures
   - Understand system
   - Understand complaint
   - Communication with operator
   - Operational test
   - Visual inspection
   - Form all possible conclusions
   - Test conclusions
   - System component isolation

3. Review the importance of following manufacturers’ diagnostic procedures where available
   - Time saving
   - Warranty requirements
   - Diagnosis may not be possible any other way

4. Review the importance of failure analysis
   - Repeat failure
   - Extended life
   - Cost
   - Customer satisfaction
Line D: SERVICE WHEELED EQUIPMENT AND ATTACHMENTS

Competency: D-4 Service Steering Systems

Objectives
1. The learner will be able to describe the construction and operation of power steering systems
2. The learner will be able to troubleshoot and service power steering systems

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Line G: SERVICE HYDRAULIC SYSTEMS
Competency: G-1 Describe Hydraulic Systems

Objectives
1. The learner will be able to describe the principles of hydraulics.
2. The learner will be able to describe the construction and operation of hydraulic components.
3. The learner will be able to describe the application of components in hydraulic systems.
4. The learner will be able to interpret hydraulic diagrams.

LEARNING TASKS

1. Review the principles of hydraulics
   - Fluid characteristics
   - Pascal’s Law
   - Calculations
   - Imperial
   - Metric
   - Force
   - Pressure
   - Area
   - Hydraulic power ratings
   - Bernoulli’s Principle
   - Terminology
   - Advantages/disadvantages

2. Describe the construction and operation of hydraulic components
   - Types
   - Reservoir
   - Pumps
   - Actuators
   - Control valves
   - Accumulators
   - Connecting lines
   - Fluids

3. Describe the application of components in hydraulic systems
   - Open centre
   - Closed centre
   - Open loop
   - Closed loop
   - Pressurized
   - Vented
   - Load sensing
   - Pilot systems
   - Electronically controlled systems

4. Interpret hydraulic diagrams
   - Types
   - Schematics
   - Symbols
   - Pictorals
   - Standards
Line G: SERVICE HYDRAULIC SYSTEMS
Competency: G-2 Service Hydraulic Systems

Objectives
1. The learner will be able to troubleshoot hydraulic systems
2. The learner will be able to service hydraulic systems and components
3. The learner will be able to service electronic hydraulic systems

LEARNING TASKS

1. Troubleshoot hydraulic systems
   - Safety precautions
   - Diagnostic procedures
   - As per Competency C-9
   - Test equipment
   - Pressure gauges
   - Flow meters
   - Temperature sensors
   - Stop watch
   - Diagnostic codes
   - Manufacturers’ procedures

2. Service hydraulic systems and components
   - Safety precautions
   - Components
   - Reservoirs
   - Pumps
   - Actuators
   - Control valves
   - Accumulators
   - Coolers
   - Connecting lines
   - Fluids
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - System flushing
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
   - Filters
   - Strainers
   - Fluid levels
3. Service electronic hydraulic systems

- Safety precautions
- Sensors
- Actuators
- Wiring and connectors
- Electronic control module (ECM)
- Remove
- Repair or replace
- Install
- Testing
**Line H: SERVICE HYDRAULIC BRAKE SYSTEMS**

**Competency:** H-1 Describe Hydraulic Brake Systems

**Objectives**

1. The learner will be able to describe the principles of braking
2. The learner will be able to describe the construction and operation of foundation brakes
3. The learner will be able to describe the construction and operation of brake system hydraulics
4. The learner will be able to select hydraulic brake fluids
5. The learner will be able to describe the construction and operation of parking brakes

**LEARNING TASKS**

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<th>TASK</th>
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</table>
| 1. Review principles of braking | - Friction  
- Definition  
- Coefficient  
- Heat  
- Absorbing  
- Dissipating  
- Effects of speed and weight  
- Brake fade |
| 2. Review the foundation Brake | - Types  
- Disk  
- Drum  
- Components  
- Operation  
- Self energizing and non-self energizing  
- Servo/non-servo |
| 3. Review hydraulic principles | - Pressure, force and area |
| 4. Review the hydraulics of a brake system | - Types  
- Disk  
- Drum  
- Components  
- Operation |
| 5. Select brake fluids | - Requirements  
- Characteristics  
- Identification |
| 6. Review parking brake systems | - Types  
- Components  
- Operation |
# Service Hydraulic Brake Systems

**Line H:** SERVICE HYDRAULIC BRAKE SYSTEMS  
**Competency:** H-2 Service Hydraulic Brake Systems

## Objectives

1. The learner will be able to perform preventive maintenance on hydraulic brake systems
2. The learner will be able to perform a complete wheel brake inspection
3. The learner will be able to troubleshoot hydraulic brake systems
4. The learner will be able to service hydraulic brake systems
5. The learner will be able to service parking brake systems

## Learning Tasks

### Content

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| 1. Perform preventive maintenance | • Inspection  
  • Operational test  
  • Fluid level checks  
  • Adjustment  
  • Lubrication |
| 2. Troubleshoot hydraulic brake systems | • Diagnostic procedures  
  • As per Competency C-9  
  • Inspection  
  • As per Commercial Vehicle Inspection Program (CVIP)  
  • Testing |
| 3. Repair hydraulic brake systems | • Components  
  • Hydraulic  
  • Mechanical  
  • Inspection  
  • Remove  
  • Repair or replace  
  • Install  
  • Flushing  
  • Bleeding  
  • Adjustments  
  • Lubrication  
  • Testing  
  • Scheduled maintenance |
| 4. Service parking brake systems | • Troubleshooting  
  • Inspection  
  • Remove repair or replace  
  • Install  
  • Adjustments  
  • Lubrication  
  • Testing  
  • Scheduled maintenance |
Line H: SERVICE HYDRAULIC BRAKE SYSTEMS

Competency: H-3 Service Power Brake Systems

Objectives

1. The learner will be able to describe power brake systems
2. The learner will be able to perform preventive maintenance on power brake systems
3. The learner will be able to troubleshoot power brake systems
4. The learner will be able to service power brake systems

LEARNING TASKS

1. Review the power brake systems
   - Types
   - Vacuum booster
   - Hydro-boost
   - Hydro-max
   - Components
   - Operation

2. Perform preventive maintenance on power brake systems
   - Inspection
   - Operational checks

3. Troubleshoot power brake systems
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
   - Testing

4. Service power brake systems
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustment
   - Testing
   - Scheduled maintenance
Line H: SERVICE HYDRAULIC BRAKE SYSTEMS
Competency: H-4 Service Anti-Lock Brake Systems

Objectives
1. The learner will be able to describe hydraulic anti-lock braking (ABS) systems
2. The learner will be able to troubleshoot and service hydraulic anti-lock braking (ABS) systems

LEARNING TASKS
1. Describe hydraulic anti-lock braking systems
   - Types
   - Components
   - Operation
   - Precautions

2. Troubleshoot hydraulic anti-lock braking systems
   - Manufacturers’ diagnostic procedures
   - Road test
   - Diagnostic codes
   - Components
   - Inspection
   - Testing

3. Service hydraulic anti-lock braking systems
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustment
   - Testing
   - Diagnostic codes
Line H: SERVICE AIR BRAKE SYSTEMS
Competency: I-1 Service Air Brake Systems

Objectives
1. The learner will be able to describe the principles of pneumatics
2. The learner will be able to describe air brake schedules and their components
3. The learner will be able to troubleshoot and service air brake schedules and their components
   The learner will be encouraged to obtain an air brake endorsement on their driver’s license.

LEARNING TASKS

1. Review the principles of pneumatics
   - Characteristics of air
   - Relationship between force, pressure and area
   - Effects of heat on air

2. Review a basic air brake system
   - Sub system
   - Supply
   - Delivery
   - Foundation brakes
   - Components
   - Operation

3. Review tractor air brake schedules and their components
   - 121
   - BT-75
   - T-75
   - L-75

4. Troubleshoot tractor air brake schedules and their components
   - Diagnostic procedures
   - As per Competency C-9
   - Inspection
   - As per Commercial Vehicle Inspection Program (CVIP)
   - Testing

5. Service tractor air brake components
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance

6. Review trailer air brake schedules and their components
   - 121 trailers
   - S
   - SX
   - Converter dollies
7. Troubleshoot trailer air brakes schedules and their components
   - Diagnostic procedures
   - As per Competency C-9
   - Inspection
   - As per Commercial Vehicle Inspection Program (CVIP)
   - Testing

8. Service trailer air brake components
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustment
   - Lubrication
   - Testing
   - Scheduled maintenance

9. Review pre-trip brake inspection
   - As per motor vehicle standards

10. Perform a pre-trip brake inspection
    - As per motor vehicle standards
Program Content
Level 1

Line H: SERVICE AIR BRAKE SYSTEMS
Competency: I-2 Service Anti-Lock Brake Systems

Objectives
1. The learner will be able to describe air operated anti-lock braking systems with and without traction control
2. The learner will be able to troubleshoot and service air operated anti-lock braking systems with and without traction control

LEARNING TASKS

1. Describe air anti-lock braking systems
   - Types
   - Components
   - Operation
   - Precautions

2. Troubleshoot air anti-lock braking systems
   - Manufacturers’ diagnostic procedures
   - Road test
   - Diagnostic codes
   - Components
   - Inspections
   - Testing

3. Service air anti-lock braking systems
   - Inspection
   - Remove
   - Repair/replace
   - Install adjustments
   - Testing
   - Diagnostic codes

4. Describe air anti-lock with traction control braking systems
   - Types
   - Components
   - Operation
   - Precautions

5. Troubleshoot air anti-lock with traction control braking systems
   - Manufacturers’ diagnostic procedures
   - Road test
   - Diagnostic codes
   - Components
   - Inspection
   - Testing
Line H: SERVICE AIR BRAKE SYSTEMS
Competency: I-3 Service Air-Over-Hydraulic Brake Systems

Objectives
1. The learner will be able to describe air over hydraulic systems and their components
2. The learner will be able to troubleshoot and service air over hydraulic systems and their components

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<td>2. Troubleshoot air over hydraulic braking systems and their components</td>
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<td>3. Service air over hydraulic braking components</td>
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</table>
Line J:  
SERVICE ALTERNATIVE BRAKE SYSTEMS

Competency:  
J-1  Describe Dynamic Brake Systems

Objectives
1. The learner will be able to describe the construction and operation of various dynamic brake systems

LEARNING TASKS
1. Review dynamic brake systems

CONTENT
- Types
  - Hydraulic retarder
  - Electric retarder
  - Engine brake
  - Exhaust brake
- Construction
- Operation
Line J: SERVICE ALTERNATIVE BRAKE SYSTEMS
Competency: J-2 Service Expanding Tube Type Brakes

Objectives
1. The learner will be able to describe the construction and operation of expanding tube brakes
2. The learner will be able to troubleshoot and service expanding tube type brakes

LEARNING TASKS
1. Review expanding tube type brakes
   - Construction
   - Operation

2. Troubleshoot expanding tube type brakes
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspections
   - Testing

3. Service expanding tube type brakes
   - Inspections
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
Line J: SERVICE ALTERNATIVE BRAKE SYSTEMS
Competency: J-3 Service Multi-Disc Brake Systems

Objectives
1. The learner will be able to describe the construction and operation of multi-disc brakes
2. The learner will be able to troubleshoot and service multi-disc brakes

LEARNING TASKS

1. Describe multi-disc brake systems
   - Construction
   - Operation

2. Troubleshoot multi-disc brakes
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
   - Testing

3. Service multi-disc brakes
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance

CONTENT
Line (K): SERVICE AIR OPERATED SYSTEMS
Competency: K-2 Service Air Start Systems

Objectives
1. The learner will be able to describe air start systems
2. The learner will be able to troubleshoot and service air start systems

LEARNING TASKS

1. Describe air start systems
   • Components
   • Reservoir
   • Motor
   • Control systems
   • Relay valves
   • Automatic oilers
   • Operation

2. Troubleshoot air start systems
   • Diagnostic procedures
   • As per Competency C-9
   • Operational test
   • Components
   • Inspections
   • Testing

3. Service air start systems
   • Inspections
   • Remove
   • Repair or replace
   • Install
   • Adjustments
   • Lubrication
   • Testing
   • Scheduled maintenance
Objectives

1. The learner will be able to describe air operated controls and accessories
2. The learner will be able to troubleshoot and service air operated controls and accessories

LEARNING TASKS

1. Describe the operation of air operated controls and accessories
   - Types
   - Air throttles
   - Power take-off control
   - Solenoid operated air controls
   - Transmission controls
   - Differential controls
   - Components
   - Operation

2. Troubleshoot air operated controls and accessories
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspections
   - Testing

3. Service air operated controls and accessories
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Testing
   - Scheduled maintenance
Level 2

Heavy Duty Equipment Mechanic
Line C: APPLY WORK PRACTICES AND PROCEDURES
Competency: C-5 Use Lubricants

Objectives
1. The learner will be able to select and use engine lubricants

LEARNING TASKS
CONTENT
1. Review the theory of lubrication
   - Friction
   - Purpose
2. Review the properties of engine lubricants
   - Properties
   - Viscosity
   - Viscosity index
   - Additives
   - Types
   - Oils
   - Assembly greases
   - Synthetics
   - Ratings
   - American Petroleum Institute (API)
   - Society of Automotive Engineers (SAE)
   - Multi-viscosity
3. Select and use lubricants
   - Applications
   - Oils
   - Assembly greases
   - Synthetics
   - Manufacturers’ specifications
   - Minimum requirements
   - Warranty issues
4. Handle lubricants
   - Storage
   - Disposal
   - Personal protection
Line C: APPLY WORK PRACTICES AND PROCEDURES  
Competency: C-9 Describe Diagnostic Procedures

Objectives
1. The learner will be able to describe the importance of following a diagnostic process
2. The learner will be able to describe diagnostic procedures used for troubleshooting

LEARNING TASKS

1. Review the importance of following a diagnostic process
   - Cost of improper diagnosis
   - Unhappy customer
   - Lost business
   - Time management
   - Efficiency
   - Damage to components

2. Review general diagnostic procedures
   - Understand system
   - Understand complaint
   - Communicate with operator
   - Operational test
   - Visual inspection
   - Form all possible conclusions
   - Test conclusions
   - System component isolation

3. Review the importance of following manufacturers' diagnostic procedures where available
   - Time saving
   - Warranty requirements
   - Diagnosis may not be possible any other way

4. Review the importance of failure analysis
   - Repeat failure
   - Extended life
   - Cost
   - Customer satisfaction
Line J: SERVICE ALTERNATING BRAKE SYSTEMS
Competency: J-4 Service Engine Brakes

Objectives
1. The learner will be able to describe engine brakes
2. The learner will be able to troubleshoot and service engine brakes

LEARNING TASKS

1. Review engine brakes
   - Types
   - Compression
   - Exhaust
   - Components
   - Operation

2. Troubleshoot engine brakes
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Diagnostic codes
   - Components
   - Inspections
   - Testing

3. Service engine brakes
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustments
   - Testing
   - Diagnosis codes
   - Scheduled maintenance
Line J: SERVICE ALTERNATING BRAKE SYSTEMS
Competency: J-5 Service Hydraulic Retarders

Objectives
1. The learner will be able to describe engine mounted hydraulic retarders
2. The learner will be able to troubleshoot and service engine mounted hydraulic retarders

LEARNING TASKS

1. Review hydraulic retarders
   - Types
   - Engine mounted
   - Components
   - Operation

2. Troubleshoot engine mounted hydraulic retarders
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
   - Testing

3. Service engine mounted hydraulic retarders
   - Inspection
   - Remove
   - Repair or replace
   - Install
   - Adjustment
   - Testing
   - Scheduled maintenance
Program Content
Level 2

Line L: SERVICE DIESEL ENGINES
Competency: L-1 Describe the Theory of Internal Combustion Engines

Objectives
1. The learner will be able to describe the combustion process
2. The learner will be able to describe terminology and perform calculations related to engines
3. The learner will be able to describe the principles of operation of two and four stroke cycle internal combustion engines

LEARNING TASKS

1. Review the combustion process
   - Composition of air
   - Composition of fossil fuels
   - Requirements for combustion
   - Combining air, fuel and heat
   - Heat value and energy of fuel
   - By-products of combustion

2. Review terminology and perform calculations related to engines
   - Concepts
   - Work
   - Energy
   - Heat
   - BTU's
   - Joules
   - Inertia
   - Friction
   - Power
   - Kilowatts
   - Horsepower
   - Bore and stroke
   - Displacement
   - Compression ratio
   - Torque
   - Volumetric efficiency
   - Metric and imperial formulae for Power
   - Kilowatts
   - Horsepower
   - Bore and stroke
   - Displacement
   - Compression ratio
   - Torque

3. Review internal combustion engine classification
   - Fuel
   - Cooling
   - Ignition
   - Number of cylinders
   - Firing order
   - Cycle type
   - Cylinder configuration
   - Aspiration
4. Review the operation of four stroke internal combustion engines

- Rotation
- Intake
- Compression
- Power exhaust
- Timing
- Valve overlap
- Relative cycle times
Line L: SERVICE DIESEL ENGINES
Competency: L-3 Service Engines

Objectives
1. The learner will be able to describe the construction and operation of engine components
2. The learner will be able to overhaul a heavy equipment engine

LEARNING TASKS

1. Review the construction and operation of engine components
   - Head valve train
   - Block
   - Internal components
   - Attachments

2. Prepare for overhaul
   - Safety
   - Types of overhaul
   - Cleaning
   - Removal of attachments
   - Environmental concerns

3. Disassemble an engine
   - Manufacturers’ procedures
   - Inspection
   - Initial engine measurements
   - Determine initial parts and component requirements
   - Cleaning and care of components

4. Repair or replace components
   - Manufacturers’ procedures
   - Inspection
   - Component measurements
   - Component requirements
   - Repair or replace
   - Cleaning and care of components

5. Reassemble an engine
   - Manufacturers’ procedures
   - Assembly measures
   - Pre-lube of components
   - Timing
   - Mounting of attachments
   - Preparation for installation or storage
**Line L: SERVICE DIESEL ENGINES**

**Competency:** L-4 Service Engine Support Systems

**Objectives**

1. The learner will be able to describe engine support systems
2. The learner will be able to troubleshoot and service engine support systems

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe cooling systems | • Types  
• Coolants  
• Types  
• Tests  
• Components  
• Main systems  
• Fan systems  
• Shutter systems  
• Operation |
| 2. Troubleshoot cooling systems | • Diagnostic procedures  
• As per Competency C-9  
• Operational test  
• Diagnostic codes  
• Components  
• Inspection  
• Testing |
| 3. Service and maintain cooling systems and their components | • Inspection  
• Remove  
• Repair/replace  
• Install  
• Adjustments  
• Testing  
• Diagnostic codes  
• Scheduled maintenance |
| 4. Describe lubrication systems | • Types  
• Lubricants  
• Components  
• Operation  
• Filter and cooler circuits |
| 5. Troubleshoot lubrication systems | • Diagnostic procedures  
• As per Competency C-9  
• Diagnostic codes  
• Components  
• Inspection  
• Testing |
| 6. Service lubrication systems and components | • Inspection  
• Remove  
• Repair/remove |
7. Describe air induction systems
- Install
- Adjustments
- Testing
- Diagnostic codes
- Scheduled maintenance
- Oil analysis
- Filter service

8. Troubleshoot air induction
- Types
- Components
- Naturally aspirated type
- Boosted type
- Operation

9. Service air induction systems and components
- Precautions
- Inspections
- Remove
- Repair/replace
- Install
- Adjustments
- Lubrication
- Testing diagnostic codes
- Scheduled maintenance

10. Describe exhaust systems
- Types
- Components
- Operation

11. Troubleshoot exhaust systems
- Diagnostic procedures
- As per Competency C-9
- Diagnostic codes
- Components
- Inspection
- Testing

12. Service exhaust systems and their components
- Inspection
- Remove
- Repair/replace
- Install
- Adjustments
- Testing
- Diagnostic codes
- Scheduled maintenance
Line L: SERVICE DIESEL ENGINES
Competency: L5 Perform Start-up Procedures and Running Checks

Objectives
1. The learner will be able to perform pre-start checks and procedures on diesel engines
2. The learner will be able to start, monitor and shutdown diesel engines

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe pre-start checks and procedures</td>
<td>• Shutdown/emergency shut-down</td>
</tr>
<tr>
<td></td>
<td>• Controls</td>
</tr>
<tr>
<td></td>
<td>• Pre-lube</td>
</tr>
<tr>
<td></td>
<td>• Fuel priming</td>
</tr>
<tr>
<td></td>
<td>• Pre-start adjustments</td>
</tr>
<tr>
<td></td>
<td>• Electrical connections</td>
</tr>
<tr>
<td></td>
<td>• Safety precautions</td>
</tr>
<tr>
<td>2. Describe start and operational procedures</td>
<td>• Start-up procedures</td>
</tr>
<tr>
<td></td>
<td>• Engine monitoring</td>
</tr>
<tr>
<td></td>
<td>• Shut-down</td>
</tr>
<tr>
<td></td>
<td>• Safety precautions</td>
</tr>
<tr>
<td>3. Perform pre-start, start and operational</td>
<td>• Pre-start procedures</td>
</tr>
<tr>
<td>procedures</td>
<td>• Start-up procedures</td>
</tr>
<tr>
<td></td>
<td>• Engine monitoring</td>
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<td></td>
<td>• Shut-down</td>
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<tr>
<td></td>
<td>• Safety precautions</td>
</tr>
</tbody>
</table>
Line L: SERVICE DIESEL ENGINES
Competency: L-6 Perform Troubleshooting Procedures on Diesel Engines

Objectives
1. The learner will be able to troubleshoot and identify problems on a diesel engine

LEARNING TASKS
1. Describe troubleshooting procedures and tests for engines

CONTENT
- Types of problems
  - Lack of power
  - Hard starting
  - Rough running
  - Frequent stalling
  - Variation in exhaust smoke
  - Abnormal engine temperatures
  - Abnormal oil consumption
  - Excessive vibration and noise
  - No start
- Types of tests
  - Blow by
  - Compression
  - Boost pressure
  - Oil pressure
  - Coolant system pressure
  - Cylinder balance
  - Valve adjustment
  - Diagnostic codes
  - Performance
  - Exhaust temperature

2. Perform troubleshooting and tests for engines

- Same as Learning Task 1
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-1 Describe Basic Principles of Electricity

Objectives
1. The learner will be able to define electrical terminology
2. The learner will be able to explain basic circuit concepts
3. The learner will be able to perform circuit calculations
4. The learner will be able to describe magnetic theory

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>1. Review electrical terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Electrical quantities and their units and prefixes</td>
</tr>
<tr>
<td>• Voltage</td>
</tr>
<tr>
<td>• Current</td>
</tr>
<tr>
<td>• Resistance</td>
</tr>
<tr>
<td>• Power</td>
</tr>
<tr>
<td>• Circuit terminology</td>
</tr>
<tr>
<td>• Open circuit</td>
</tr>
<tr>
<td>• Closed circuit</td>
</tr>
<tr>
<td>• Short circuit</td>
</tr>
<tr>
<td>• Continuity</td>
</tr>
<tr>
<td>• Ground</td>
</tr>
<tr>
<td>• Ground fault</td>
</tr>
<tr>
<td>• Series circuit</td>
</tr>
<tr>
<td>• Parallel circuit</td>
</tr>
<tr>
<td>• Series parallel circuit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Review basic circuit concepts and perform calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sources of electricity</td>
</tr>
<tr>
<td>• Atomim theory</td>
</tr>
<tr>
<td>• Current flow</td>
</tr>
<tr>
<td>• Conductors</td>
</tr>
<tr>
<td>• Insulators</td>
</tr>
<tr>
<td>• Semiconductors</td>
</tr>
<tr>
<td>• Basic circuit</td>
</tr>
<tr>
<td>• Sources</td>
</tr>
<tr>
<td>• Load</td>
</tr>
<tr>
<td>• Complete path</td>
</tr>
<tr>
<td>• Electrical relationships</td>
</tr>
<tr>
<td>• Ohm’s law</td>
</tr>
<tr>
<td>• Watt’s law (P=ExI)</td>
</tr>
<tr>
<td>• Series circuits</td>
</tr>
<tr>
<td>• Parallel circuits</td>
</tr>
<tr>
<td>• Series parallel circuits</td>
</tr>
</tbody>
</table>
3. Review magnetic theory

- Properties of magnetic lines of force
- Terminology
- Flux
- Flux density
- Reluctance
- Relationship to electric current
- Left-hand rule for conductors
- Left-hand rule for coils
- Electromagnetic induction
- Types
- Requirements
- Factors affecting magnitude
- Effect of magnetic core on coils
- Concept of signal interference
Program Content
Level 2

Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-2 Identify Common Electrical and Electronic Components

Objectives
1. The learner will be able to identify common electrical and electronic components
2. The learner will be able to interpret wiring diagrams and symbols

LEARNING TASKS

1. Review common electrical components
   - Lamps
   - Switches
   - Relays
   - Solenoids
   - Resistors
   - Fixed
   - Variable
   - Capacitors
   - Motors
   - Alternators
   - Fuses

2. Review the function of common electronic components
   - Semiconductors
   - Diodes
   - Standard only
   - Transistors

3. Review basic electrical wiring diagrams
   - Types of diagrams
   - Symbols
   - Conventions
   - Abbreviations
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-3 Use Electrical Testing Instruments

Objectives
1. The learner will be able to use electrical measuring devices

LEARNING TASKS
1. Review use electrical measuring devices
   - Analog vs. digital
   - Voltmeters
   - Ammeters
   - Ohmmeters
   - Multimeters (VOM)
   - VAT’s (Volt amp testers)
   - Load testers
   - Continuity testers
   - Test lights
   - Safety precautions

2. Use electrical measuring devices
   - Voltage drops shorts
   - Grounds
   - Opens
   - Circuit loads
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-4 Service Electrical/Electronic Circuits

Objectives
1. The learner will be able to test and repair limited electrical and electronic circuit faults
2. The learner will be able to describe trailer wiring

LEARNING TASKS
1. Select conductors and install terminations
2. Diagnose circuit faults
3. Describe trailer wiring circuits

CONTENT
- Wire gauge/Ampacity
- Connector types
- Voltage drops shorts grounds
- Opens
- High resistance
- Use circuit diagrams
- Connectors
- Cord
- Junction
- Wiring harness
# Program Content

## Level 2

### Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS

#### Competency: M-5 Service Batteries

### Objectives
1. The learner will be able to describe battery design and operation
2. The learner will be able to select, test and maintain batteries
3. The learner will be able to diagnose causes of battery failure
4. The learner will be able to remove and replace batteries
5. The learner will be able to use booster batteries

### LEARNING TASKS

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Review safety considerations when working with batteries | - Personal protection  
- Hydrogen gassing  
- Acid  
- Frozen batteries  
- Short circuit capacity (arcing)  
- Environmental considerations |
| 2. Review the design and construction of a lead acid battery | - Plates  
- Plate straps  
- Separators  
- Electrolyte  
- Case  
- Terminals |
| 3. Review the chemical action that takes place in a lead acid battery during charging and discharging | - Charging cycle  
- Discharging cycle |
| 4. Review the various types of batteries | - Low maintenance  
- Maintenance free  
- Deep-cycle  
- Recombination  
- Gel cell |
| 5. Select batteries | - Battery rating methods  
- Physical dimensions |
| 6. Maintain batteries | - Safety precautions  
- Factors affecting the life cycle of batteries  
- Inspections  
- Cleaning  
- Terminal servicing  
- Charging  
- Replacement  
- Schedule maintenance  
- Storage and handling |
| 7. Test batteries | - Specific gravity  
- Open circuit voltage test  
- Load test |
3 minute fast charge test

- 8. Use booster batteries
- Safety
- Voltage
- 12
- 24
- 12/24
- Polarity
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-8 Service Electrical/Electronic Alarm Systems

Objectives
1. The learner will be able to describe engine alarm systems
2. The learner will be able to troubleshoot and service engine alarm systems

LEARNING TASKS

1. Describe engine alarm systems
   - Types
   - Kysor
   - Murphy
   - Components
   - Operation

2. Troubleshoot engine alarm systems
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
   - Testing

3. Service engine alarm systems
   - Inspections
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Testing
   - Scheduled maintenance
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-1 Service Gasoline Fuel Systems

Objectives
1. The learner will be able to describe the characteristics of gasoline
2. The learner will be able to describe the construction and operation of carburetors
3. The learner will be able to troubleshoot and service carburetors

LEARNING TASKS

1. Review the characteristics of gasoline
   • Physical properties
   • Heat value
   • Octane
   • Storage considerations

2. Describe carburetor operation
   • Types
   • Components
   • Operation
   • Circuits

3. Troubleshoot carburetors
   • Diagnostic procedures
   • As per Competency C-9
   • Operation test
   • Components
   • Inspection
   • Testing

4. Service carburetors
   • Inspection
   • Remove
   • Repair/replace
   • Install
   • Adjustments
   • Testing
   • Scheduled maintenance
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-2 Describe Propane Fuel Systems

Objectives
1. The learner will be able to describe the characteristics of liquefied petroleum gas (LPG)
2. The learner will be able to describe the construction and operation of a LPG system

LEARNING TASKS
1. Review the characteristics of liquefied petroleum gas (LPG)
2. Describe LPG systems

CONTENT
- Physical properties
- Heat value
- Octane
- Storage considerations
- Types
- Components
- Operation
- Pressure fuel Regulations
Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-3 Describe Natural Gas Fuel Systems

Objectives
1. The learner will be able to describe the characteristics of compressed natural gas (CNG)
2. The learner will be able to describe the construction and operation of a CNG system

LEARNING TASKS
1. Review the characteristics of compressed natural gas (CNG)

2. Describe CNG systems

CONTENT
- Physical properties
- Heat value
- Octane
- Storage consideration
- Types
- Components
- Operation
- Pressure fuel regulations
Program Content
Level 2

Line O: SERVICE MECHANICAL DIESEL FUEL SYSTEMS
Competency: O-2 Service Fuel Supply Circuits

Objectives
1. The learner will be able to describe diesel fuel supply circuits and their components
2. The learner will be able to perform limited service on diesel supply circuits

LEARNING TASKS
1. Review diesel fuel supply circuits
   • Types
   • Components
   • Water separators
   • Filters
   • Transfer pumps
   • Tank
   • Operation
   • Inspection
   • Filter replacement
   • Priming
   • Scheduled maintenance

2. Service diesel fuel supply circuits
Line O: SERVICE MECHANICAL DIESEL FUEL SYSTEMS
Competency: O-4 Service High Pressure Fuel Injection Pumps

Objectives
1. The learner will be able to describe the installation and timing procedures for high pressure fuel injection pumps
2. The learner will be able to install and time high pressure fuel injection pumps

LEARNING TASKS

1. Describe installation and timing procedures
   - Types
   - Rotary
   - Inline
   - Construction
   - Operating principles
   - Methods
   - Spill
   - Pin
   - Pointer
   - Timing
   - As per manufacturers’ specifications

2. Install and time high pressure fuel injection pumps
Line O: SERVICE MECHANICAL DIESEL FUEL SYSTEMS

Competency: O-5 Service Hydraulic Fuel Injectors

Objectives
1. The learner will be able to describe the installation of hydraulic fuel injectors
2. The learner will be able to install hydraulic fuel injectors

LEARNING TASKS
1. Describe the installation of hydraulic fuel injectors
   • Types
   • Construction
   • Operating principles
   • Procedures

2. Install hydraulic fuel injectors
   • As per manufacturers’ specifications
Objectives
1. The learner will be able to describe the installation of a PT pump
2. The learner will be able to install a PT pump
3. The learner will be able to describe fuel injection timing
4. The learner will be able to time fuel injection
5. The learner will be able to describe fuel injector installation and adjustment
6. The learner will be able to install and adjust fuel injectors

<table>
<thead>
<tr>
<th>Learning Tasks</th>
<th>Content</th>
</tr>
</thead>
</table>
| 1. Describe the installation of a PT pump | - PT operating principles
|  | - Installation
|  | - As per manufacturers’ specifications
|  | - As per manufacturers’ specifications
| 2. Install a PT pump | - Methods
|  | - Cam follower shims
|  | - Offset keys
|  | - As per manufacturers’ specifications
| 3. Describe injection timing | - As per manufacturers’ specifications
| 4. Time fuel injection | - As per manufacturers’ specifications
| 5. Describe fuel injector installation and adjustments | - As per manufacturers’ specifications
| 6. Install and adjust fuel injectors | - As per manufacturers’ specifications
Program Content  
Level 2

Line O: SERVICE MECHANICAL DIESEL FUEL SYSTEMS
Competency: O-7 Service Unit Injector Fuel Injection Systems

Objectives
1. The learner will be able to describe the operating principles of unit fuel injectors
2. The learner will be able to describe the installation and adjustment of unit fuel injectors
3. The learner will be able to install and adjust unit fuel injectors

LEARNING TASKS

1. Describe unit injector fuel systems
2. Describe unit fuel injector installation and adjustments
3. Install and adjust unit fuel injectors

CONTENT
- Components
- Operating principles
- As per manufacturers’ specifications
- Procedures
- As per manufacturers’ specifications
Level 3

Heavy Duty Equipment Mechanic
### Line C: APPLY WORK PRACTICES AND PROCEDURES

**Competency:** C-9 Describe Diagnostic Procedures

#### Objectives
1. The learner will be able to describe the importance of following a diagnostic process
2. The learner will be able to describe diagnostic procedures used for troubleshooting

#### LEARNING TASKS

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Review the importance of following a diagnostic process</td>
</tr>
<tr>
<td>2.</td>
<td>Review general diagnostic procedures</td>
</tr>
<tr>
<td>3.</td>
<td>Review the importance of following manufacturers’ diagnostic procedures where available</td>
</tr>
</tbody>
</table>

#### CONTENT
- Cost of improper diagnosis
- Unhappy customer
- Lost business
- Time management
- Efficiency
- Damage to components
- Understand system
- Understand complaint
- Communicate with operator
- Operational test
- Visual inspection
- Form all possible conclusions
- Test conclusions
- System component isolation
- Time saving
- Warranty requirements
- Diagnosis may not be possible any other way
Program Content
Level 3

Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-1 Describe Basic Principles of Electricity

Objectives
1. The learner will be able to define electrical terminology
2. The learner will be able to explain basic circuit concepts
3. The learner will be able to perform circuit calculations
4. The learner will be able to describe magnetic theory

LEARNING TASKS
1. Review electrical terminology
   • Electrical quantities and their units and prefixes
   • Voltages
   • Current
   • Resistance
   • Power
   • Circuit terminology
   • Open circuit
   • Closed circuit
   • Short circuit
   • Continuity
   • Ground
   • Ground fault
   • Series circuit
   • Parallel circuit
   • Series parallel circuit

2. Review basic circuit concepts and perform calculations
   • Sources of electricity
   • Atomic theory
   • Current flow
   • Conductors
   • Insulation
   • Semiconductors
   • Basic circuit
   • Source
   • Load
   • Complete path
   • Electrical relationships
   • Ohm’s law
   • Watts’ law
   • Series circuits
   • Parallel circuits
   • Series parallel circuits
3. Review magnetic theory

- Properties of magnetic lines of force
- Terminology
- Flux
- Flux density
- Reluctance
- Relationship to electric current
- Left-hand rule for conductors
- Left-hand rule for coils
- Electromagnetic induction
- Types
- Requirements
- Factors affecting magnitude
- Effect of magnetic core on coils
- Concept of signal interference
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-2 Identify Common Electrical and Electronic Components

Objectives
1. The learner will be able to identify common electrical and electronic components
2. The learner will be able to interpret wiring diagrams and symbols

LEARNING TASKS

1. Review common electrical components
   - Lamps
   - Switches
   - Relays
   - Solenoids
   - Resistors
   - Fixed
   - Variable
   - Capacitors
   - Motors
   - Alternators
   - Fuses

2. Review the function of common electronic components
   - Semiconductors
   - Diodes
   - Standard only
   - Transistors

3. Review basic electrical wiring diagrams
   - Types of diagrams
   - Symbols
   - Conventions
   - Abbreviations
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-3 Use Electrical Testing Equipment

Objectives
1. The learner will be able to use electrical measuring devices

LEARNING TASKS
1. Review how to use electrical measuring devices
    - Analog vs. digital
    - Voltmeters
    - Ammeters
    - Ohmmeters
    - Multimeters (VOM)
    - VAT’s (Volt amp testers)
    - Load testers
    - Continuity testers
    - Test lights
    - Safety precautions

2. Use electrical measuring devices
    - Voltage drops
    - Shorts
    - Grounds
    - Opens
    - Circuit load
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-4 Service Electrical/Electronic Circuits

Objectives
1. The learner will be able to test and repair limited electrical and electronic circuit faults
2. The learner will be able to describe trailer wiring

LEARNING TASKS
1. Select conductors and install terminations
2. Diagnose circuit faults
3. Review trailer wiring circuits
4. Troubleshoot trailer wiring circuits
5. Service trailer wiring circuits

CONTENT
- Wire gauge/Ampacity
- Connector types
- Voltage drops
- Shorts
- Grounds
- Opens
- High resistance
- Use circuit diagrams
- Connectors
- Cord
- Junction box
- Wiring harness
- Diagnostic procedures
- As per Competency C-9
- Operational test
- Components
- Inspection
- Testing
- Inspection
- Repair/replace
- Testing
- Scheduled maintenance
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: M-5 Service Batteries

Objectives
1. The learner will be able to describe battery design and operation
2. The learner will be able to select, test and maintain batteries
3. The learner will be able to diagnose causes of battery failure
4. The learner will be able to remove and replace batteries
5. The learner will be able to use booster batteries

LEARNING TASKS

1. Review safety considerations when working with batteries
   - Personal protection
   - Hydrogen gassing
   - Acid
   - Frozen batteries
   - Short circuit capacity
   - Environmental considerations

2. Review the design and construction of a lead acid battery
   - Plates
   - Plate straps
   - Separators
   - Electrolyte
   - Case
   - Terminals

3. Review the chemical action that takes place in a lead acid battery during charging and discharging
   - Charging cycle
   - Discharging cycle

4. Review the various types of batteries
   - Low maintenance
   - Maintenance free
   - Deep cycle
   - Recombination
   - Gel cell

5. Select battery
   - Battery rating methods
   - Physical dimensions

6. Maintain batteries
   - Safety precautions
   - Factors affecting the life cycle of batteries
   - Inspection
   - Cleaning
   - Terminal servicing
   - Charging
   - Replacement
   - Scheduled maintenance
   - Storage and handling

7. Test batteries
   - Specific gravity
   - Open circuit voltage test
   - Load test
Program Content
Level 3

- 3 minute fast charge test

8. Use booster batteries

- Safety
- Voltage
- 12
- 24
- 12/24
- Polarity
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-6 Service Starting Systems

Objectives
1. The learner will be able to identify starting systems components
2. The learner will be able to describe the design and operation of starting systems
3. The learner will be able to troubleshoot and repair starting systems and their components

LEARNING TASKS

1. Review components of starting systems
   • Battery
   • Variations
   • Starter motor assembly
   • Solenoids and relays
   • Ring gear
   • Ignition switch
   • Neutral safety switch/clutch pedal switch
   • Cables and terminals
   • Anti-theft devices

2. Describe the design and operation of starting motor assemblies
   • Motor
   • Variations
   • Drives
   • Variations
   • Solenoids, relays and switches

3. Troubleshoot starting systems
   • Inspections
   • Operation
   • Testing
   • System test
   • Component test

4. Service starting system components
   • Inspection
   • Remove
   • Bench tests
   • Repair/replace
   • Install
   • Adjustments
   • Lubrication
   • Testing
   • Scheduled maintenance
   • Special test equipment
Line M: SERVICE ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: M-7 Service Charging Systems

Objectives
1. The learner will be able to identify charging system components
2. The learner will be able to describe the design and operation of charging systems
3. The learner will be able to perform inspection, diagnosis and repair of charging systems

LEARNING TASKS

1. Review the components of charging systems
   - Battery
   - Alternator assembly
   - Regulator
   - Relays
   - Ignition switch
   - Cables and terminals
   - Charging indicators
   - Belts
   - Mounts

2. Describe the design and operation of alternator assemblies
   - Alternator
   - Variations
   - Regulator
   - Variations
   - Drive methods
   - Cooling methods
   - Relays and switches

3. Troubleshoot charging systems
   - Inspection
   - Operation
   - Testing
   - System tests
   - Component tests
   - Adjustments
   - Diagnostic codes

4. Service charging system components
   - Inspection
   - Remove
   - Bench tests
   - Repair/replace
   - Rebuild
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
   - Special test equipment
   - Diagnostic codes
Line N: SERVICE SPARK IGNITION ENGINES  
Competency: N-1 Service Gasoline Fuel Systems

Objectives
1. The learner will be able to describe the characteristics of gasoline
2. The learner will be able to describe gasoline fuel injection systems
3. The learner will be able to troubleshoot and service gasoline fuel injection systems

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</table>
Line N: SERVICE SPARK IGNITION ENGINES

Competency: N-4 Service Ignition Systems

Objectives
1. The learner will be able to describe the design and operation of conventional ignition systems
2. The learner will be able to describe the design and operation of electronic ignition systems
3. The learner will be able to perform limited inspection, diagnosis and repair of electronic ignition systems

LEARNING TASKS
1. Review the design and operation of conventional ignition systems
   - Components
   - Primary and secondary circuits
   - Dwell
   - Timing
   - Ignition switch and wiring
   - Ballast resistor
   - Ignition coil
   - Distributor
   - Points
   - Condenser
   - Rotor
   - Cap
   - Advance/retard mechanisms
   - High tension leads
   - Spark plugs

2. Review the design and operation of electronic ignition systems
   - Components
   - Primary and secondary circuit
   - Variable/fixed dwell systems
   - Timing
   - Ignition switch and wiring
   - Trigger device(s)
   - Hall effect switches
   - Sensors
   - Computer
   - Signal amplifier
   - Distributor type
   - Condenser
   - Rotor
   - Cap
   - Advance/retard mechanisms
   - Ballast resistor
   - Distributorless
   - Direct ignition
   - Ignition coil(s)
   - High tension wires
   - Spark plugs
   - Connectors
3. Troubleshoot electronic ignition systems
   - Road test
   - Diagnostic codes
   - Components
   - Inspection
   - Testing
   - Special testing equipment

4. Service electronic ignition systems
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Diagnostic codes
   - Scheduled maintenance
Program Content
Level 3

Line N: SERVICE SPARK IGNITION ENGINES
Competency: N-5 Service Emission Systems

Objectives
1. The learner will be able to describe the products of combustion and vehicle emissions
2. The learner will be able to describe vehicle emissions testing
3. The learner will be able to describe emission systems

LEARNING TASKS

1. Describe emission
   - Products of complete combustion
   - Products of incomplete combustion
   - Oxides of nitrogen
   - Hydrocarbons
   - Carbon monoxide
   - Carbon dioxide
   - Oxides of sulfur
   - Particulates

2. Describe types of emission testing
   - Exhaust gas analysis

3. Describe emission control systems
   - Types
   - Positive crankcase ventilation (PCV)
   - Catalytic converters
   - Exhaust gas re-circulation (EGR)
   - Secondary air systems
   - Evaporative systems
   - Components
   - Operation
Line O: SERVICE MECHANICAL DIESEL SYSTEMS

Competency: O-1 Describe the Principles of Diesel Fuel Injection

Objectives
1. The learner will be able to describe characteristics of diesel fuel
2. The learner will be able to describe the combustion process
3. The learner will be able to describe the requirements of a diesel fuel injection system

LEARNING TASKS

1. Review characteristics of diesel fuel
   - Grades
   - Characteristics
   - Viscosity
   - Cetane
   - Rating
   - Number
   - Flash point
   - Cloud point
   - Sulfur content
   - Distillation
   - Summer/winter fuel
   - API gravity
   - Storage
   - Disposal
   - Safety precautions

2. Describe the combustion process
   - Compression ignition
   - Stages of combustion
   - Direct injection
   - Indirect injection

3. Describe fuel injection system requirements
   - Meter
   - Time
   - Quick start and end of injection
   - Delivery rate
   - Atomize
   - Pressurize
   - Distribute
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-2 Service Fuel Supply Circuits

Objectives
1. The learner will be able to describe diesel fuel supply circuits and their components
2. The learner will be able to perform troubleshooting and service on diesel supply circuits

LEARNING TASKS

1. Review diesel fuel supply circuits
   - Types
   - Components
   - Water separators
   - Filters
   - Transfer pumps
   - Tank
   - Operation

2. Troubleshoot diesel fuel supply circuits
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspections
   - Testings

3. Service diesel fuel supply circuits
   - Inspections
   - Filter replacements
   - Pump replacements
   - Priming
   - Scheduled maintenance
Program Content
Level 3

Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-3 Service Fuel Pump Governors

Objectives
1. The learner will be able to describe fuel pump governors
2. The learner will be able to troubleshoot and service fuel pump governors

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<td>• Scheduled maintenance</td>
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</table>
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-4 Service High Pressure Fuel Injection Pumps

Objectives
1. The learner will be able to describe high pressure inline and distributor injection pumps
2. The learner will be able to troubleshoot and service high pressure inline and distributor injection pumps
3. The learner will be able to describe the installation and timing procedures for high pressure fuel injection pumps
4. The learner will be able to install and time high pressure fuel injection pumps

LEARNING TASKS
1. Describe high pressure inline injection pumps
   - Types
   - Port and helix
   - Sleeve metering
   - Components
   - Operation

2. Describe high pressure distributor injection pumps
   - Types
   - Standadyne, CAV
   - Bosch VE
   - Components
   - Operation

3. Describe installation and timing procedures
   - Types
   - Rotary
   - Inline
   - Methods
   - Spill
   - Pin
   - Pointer
   - Timing light

4. Install and time high pressure fuel injection pumps
   - As per manufacturers’ specifications

5. Troubleshoot high pressure fuel injection pumps
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
   - Testing

6. Service high pressure fuel injection pumps
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustment
   - Lubrication
   - Testing
   - Scheduled maintenance
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-5 Service Hydraulic Fuel Injectors

Objectives
1. The learner will be able to describe hydraulic fuel injectors
2. The learner will be able to troubleshoot and service hydraulic fuel injectors
3. The learner will be able to describe the installation of hydraulic fuel injectors
4. The learner will be able to install hydraulic fuel injectors

LEARNING TASKS

1. Describe hydraulic fuel injectors
   - Types
   - Multi-hole
   - Single-hole
   - Pintle
   - Pencil
   - Components
   - Operations

2. Review the installation of hydraulic fuel injectors
   - Types
   - Procedures

3. Install hydraulic fuel injectors
   - As per manufacturers’ specifications

4. Troubleshoot hydraulic fuel injections
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspections
   - Testing

5. Service hydraulic fuel injectors
   - Inspections
   - Repair or replace
   - Adjustments
   - Testing
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-6 Service Cummins (PT) Fuel Systems

Objectives
1. The learner will be able to describe a PT fuel system
2. The learner will be able to troubleshoot and service a PT fuel system
3. The learner will be able to describe the installation of a PT (pressure time) pump
4. The learner will be able to install a PT pump
5. The learner will be able to describe fuel injector installation and adjustment
6. The learner will be able to install and adjust fuel injectors

LEARNING TASKS

1. Describe a PT fuel system
   • PT operating principles
   • Components
   • Operation

2. Describe the installation of a PT pump
   • As per manufacturers’ specifications

3. Install a PT pump
   • As per manufacturers’ specifications

4. Describe fuel injection installation and adjustment
   • As per manufacturers’ specifications
   • Methods

5. Install and adjust fuel injectors
   • As per manufacturers’ specifications

6. Troubleshoot a PT fuel system
   • Diagnostic procedures
   • As per Competency C-9
   • Operational test
   • Components
   • Inspections
   • Testing

7. Service PT a fuel system
   • Inspection
   • Remove
   • Replace
   • Install
   • Adjustments
   • Lubrication
   • Testing
Line O: SERVICE MECHANICAL DIESEL SYSTEMS
Competency: O-7 Service Unit Injection Fuel Systems

Objectives
1. The learner will be able to describe the operating principles of unit fuel injectors
2. The learner will be able to describe the installation and adjustment of unit fuel injectors
3. The learner will be able to install and adjust unit fuel injectors
4. The learner will be able to troubleshoot and service unit injector fuel systems

LEARNING TASKS
1. Describe unit injector fuel systems
   - Components
   - Operating principles

2. Describe unit fuel injector installation and adjustments
   - As per manufacturers’ specifications
   - Procedures

3. Install and adjust unit fuel injectors
   - As per manufacturers’ specifications

4. Troubleshoot unit injector fuel systems
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspections
   - Testing

5. Service unit injection fuel systems
   - Inspections
   - Remove
   - Replace
   - Install
   - Adjustments
   - Lubrications
   - Testing
   - Scheduled maintenance
### Objectives

1. The learner will be able to test engine performance
2. The learner will be able to diagnose engine performance problems

### LEARNING TASKS

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<th>Task</th>
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</thead>
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<td>1.</td>
<td>Test engine performance</td>
</tr>
<tr>
<td>2.</td>
<td>Diagnose engine performance problems</td>
</tr>
</tbody>
</table>

### CONTENT

- 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
- Excessive vibration and noise
- No start
- Types of tires
- Blow-by
- Compression
- Boost pressure
- Oil pressure
- Coolant system pressure
- Cylinder balance
- Valve adjustment
- Diagnostic codes
- Performance
- Exhaust temperature
- Diagnostic procedures
- As per Competency C-9
Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS

Competency: P-1 Describe the Principles of Electronic Diesel Fuel Injection

Objectives
1. The learner will be able to describe electronic control of diesel fuel systems
2. The learner will be able to identify electronic diesel fuel systems
3. The learner will be able to describe the necessary conditions for the engine to start

LEARNING TASKS

1. Describe electronic control of diesel fuel systems
   • Reason for development
   • Components
   • Operation
   • Inputs
   • Processing
   • Outputs

2. Identify electronic diesel fuel systems
   • Types
   • Partial authority
   • Cat (PEEC)
   • Bosh EP
   • Stanadyne
   • Full authority
   • Electronic unit injectors (EUI)
   • Electronic unit pump (EUP)
   • Hydraulic electronic unit injector (HEUI)
   • Bosch common rail
   • Detroit
   • Cummins

3. Describe the necessary conditions for the engine to start
   • Power to ECM
   • Connections
   • Fuses
   • Grounds
   • Engine position signal
   • Sensor/adjustment
   • Connections
   • Fuel in the system
   • Functioning mechanical systems
Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS
Competency: P-2 Service Electronic Inline Multiplunger Injection Systems

Objectives
1. The learner will be able to describe electronic inline multiplunger injection systems
2. The learner will be able to troubleshoot and service electronic inline multiplunger injection systems

LEARNING TASKS
1. Describe electronic inline multiplunger injection systems
   - Types
   - Components
   - Operation

2. Troubleshoot electronic inline multiplunger injection systems
   - Diagnostic procedures
   - As per Competency C-9
   - Manufacturers’ procedures
   - Operational test
   - Diagnostic codes
   - Components
   - Inspection
   - Testing
   - Inpection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Diagnostic codes
   - Schedule maintenance

3. Service electronic inline multiplunger injection systems
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Diagnostic codes
   - Schedule maintenance
Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS
Competency: P-3 Service Electronic Distributor Pump Injection Systems

Objectives
1. The learner will be able to describe electronic distributor pump injection systems
2. The learner will be able to troubleshoot and service electronic distributor pump injection systems

LEARNING TASKS
1. Describe electronic distributor pump injection systems
   - Types
   - Components
   - Operation
2. Troubleshoot electronic distributor pump injection systems
   - Diagnostic procedures
   - As per Competency C-9
   - Manufacturers’ procedures
   - Operational test
   - Diagnostic
   - Components
   - Inspections
   - Testing
3. Service electronic distributor pump injection systems
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Diagnostic
   - Schedule maintenance
Program Content
Level 3

Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS
Competency: P-4 Service Electronic Unit Injection Systems

Objectives
1. The learner will be able to describe electronic unit injector systems
2. The learner will be able to troubleshoot and service electronic unit injector systems

LEARNING TASKS

1. Describe electronic unit injector systems
   - Types
   - Components
   - Operation

2. Troubleshoot electronic unit injector systems
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Diagnostic codes
   - Components
   - Inspections
   - Testing

3. Service electronic unit injector systems
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Diagnostic codes
   - Scheduled maintenance
### Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS

**Competency:** P-5  Service Hydraulic Electronic Unit Injector Systems

#### Objectives
1. The learner will be able to describe hydraulic electronic unit injector systems
2. The learner will be able to troubleshoot and service hydraulic electronic unit injector systems

#### LEARNING TASKS

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<tr>
<td>2.</td>
<td>Troubleshoot hydraulic electronic unit injector systems</td>
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<td>3.</td>
<td>Service hydraulic electronic unit injector systems</td>
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#### CONTENT
- Types
- Components
- Operation
- Diagnostic procedures
- As per Competency C-9
- Operational test
- Diagnostic codes
- Components
- Inspection
- Testing
- Inspection
- Remove
- Repair or replace
- Install
- Adjustments
- Lubrication
- Testing
- Diagnostic codes
- Schedule maintenance
## Program Content

### Level 3

**Line P:** SERVICE ELECTRONIC DIESEL FUEL SYSTEMS  
**Competency:** P-6  Service Electronic Common Rail High Pressure Injection Systems

### Objectives

1. The learner will be able to describe electronic common rail high pressure injection systems
2. The learner will be able to troubleshoot and service electronic common rail high pressure injection systems

### Learning Tasks

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Diagnostic codes  
Schedule maintenance |
Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS
Competency: P-7 Service Emission Systems

Objectives
1. The learner will be able to describe the causes and effects of harmful emission
2. The learner will be able to describe emission systems found on heavy equipment
3. The learner will be able to troubleshoot and repair emission systems found on heavy equipment

LEARNING TASKS

1. Describe the causes and effects of harmful emissions
   • Combustion process
   • By products
   • Causes
   • Effects
   • Environmental
   • Health
   • Smog
   • Solutions
   • Legislation

2. Describe emission systems on diesel engines
   • Systems
   • Components and controls
   • Operation

3. Troubleshoot emission systems on diesel engines
   • Specifications
   • Manufacturers’
   • Legislated
   • Operational test
   • Diagnostic codes
   • Components
   • Inspection
   • Testing

4. Service emission systems on diesel engines
   • Inspection
   • Specifications
   • Manufacturers’
   • Legislated
   • Remove
   • Repair/replace
   • Install
   • Adjustments
   • Testing
   • Diagnostic codes
   • Scheduled maintenance
**Program Content**

**Level 3**

### Line P: SERVICE ELECTRONIC DIESEL FUEL SYSTEMS

**Competency:** P-8  Service Emerging Electronic Fuel Injection Systems

#### Objectives

1. The learner will be able to describe emerging electronic fuel injection systems
2. The learner will be able to troubleshoot and service emerging electronic fuel injection systems

#### LEARNING TASKS

<table>
<thead>
<tr>
<th>Learning Task</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe emerging electronic fuel injection systems</td>
<td>• Types</td>
</tr>
<tr>
<td></td>
<td>• Components</td>
</tr>
<tr>
<td></td>
<td>• Operation</td>
</tr>
<tr>
<td>2. Troubleshoot emerging electronic fuel injection systems</td>
<td>• Diagnostic procedures</td>
</tr>
<tr>
<td></td>
<td>• As per Competency C-9</td>
</tr>
<tr>
<td></td>
<td>• Manufacturers’ procedures</td>
</tr>
<tr>
<td></td>
<td>• Operational test</td>
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<td></td>
<td>• Diagnostic codes</td>
</tr>
<tr>
<td></td>
<td>• Components</td>
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<tr>
<td></td>
<td>• Inspection</td>
</tr>
<tr>
<td></td>
<td>• Testing</td>
</tr>
<tr>
<td>3. Service emerging electronic fuel injection systems</td>
<td>• Inspection</td>
</tr>
<tr>
<td></td>
<td>• Remove</td>
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<tr>
<td></td>
<td>• Repair/replace</td>
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<td></td>
<td>• Install</td>
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<td>• Adjustments</td>
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<td>• Lubrication</td>
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<td>• Testing</td>
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<tr>
<td></td>
<td>• Diagnostic codes</td>
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<tr>
<td></td>
<td>• Scheduled maintenance</td>
</tr>
</tbody>
</table>
Level 4

Heavy Duty Equipment Mechanic
Program Content  
Level 4  

Line C: APPLY WORK PRACTICES AND PROCEDURES  
Competency: C-6 Service Bearings and Seals  

Objectives  
1. The learner will be able to select and service bearings and seals for powertrains  

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe Bearings | • Types  
| | • Friction  
| | • Antifriction  
| | • Terminology  
| | • Applications  
| | • Loads  
| | • Axial  
| | • Radial  
| 2. Select and service bearings | • Installation  
| | • Procedure  
| | • Lubrication  
| | • Removal  
| | • Adjustments  
| | • Failure analysis  
| 3. Describe seals | • Types  
| | • Static  
| | • Dynamic  
| | • Applications  
| 4. Select and service seals | • Installation  
| | • Procedures  
| | • Sleeves  
| | • Lubrication  
| | • Removal  
| | • Failure analysis  

### Line C: APPLY WORK PRACTICES AND PROCEDURES

**Competency:** C-9 Describe Diagnostic Procedures

#### Objectives

1. The learner will be able to describe the importance of following a diagnostic process
2. The learner will be able to describe diagnostic procedures used for troubleshooting

#### LEARNING TASKS

<table>
<thead>
<tr>
<th>Task</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review the importance of following a diagnostic process</td>
<td>Cost of improper diagnosis</td>
</tr>
<tr>
<td></td>
<td>Unhappy customers</td>
</tr>
<tr>
<td></td>
<td>Lost business</td>
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<tr>
<td></td>
<td>Time management</td>
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<tr>
<td></td>
<td>Efficiency</td>
</tr>
<tr>
<td></td>
<td>Damage to components</td>
</tr>
<tr>
<td>2. Review general diagnostic procedures</td>
<td>Understand system</td>
</tr>
<tr>
<td></td>
<td>Understand complaint</td>
</tr>
<tr>
<td></td>
<td>Communicate with operator</td>
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<td></td>
<td>Operational test</td>
</tr>
<tr>
<td></td>
<td>Visual inspection</td>
</tr>
<tr>
<td></td>
<td>Form all possible conclusions</td>
</tr>
<tr>
<td></td>
<td>Test conclusions</td>
</tr>
<tr>
<td></td>
<td>System component isolation</td>
</tr>
<tr>
<td>3. Review the importance of following manufacturers' diagnostic procedures where available</td>
<td>Time saving</td>
</tr>
<tr>
<td></td>
<td>Warranty requirement</td>
</tr>
<tr>
<td></td>
<td>Diagnosis may not be possible other way</td>
</tr>
<tr>
<td>4. Review the importance of failure analysis</td>
<td>Repeat failure</td>
</tr>
<tr>
<td></td>
<td>Extended life</td>
</tr>
<tr>
<td></td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>Customer satisfaction</td>
</tr>
</tbody>
</table>
Line J: SERVICE ALTERNATIVE BRAKE SYSTEMS
Competency: J-5 Service Hydraulic Retarders

Objectives
1. The learner will be able to describe hydraulic retarders
2. The learner will be able to troubleshoot and service hydraulic retarders

LEARNING TASKS
1. Review hydraulic retarders
   - Types
   - Components
   - Operation

2. Troubleshoot hydraulic retarders
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspections
   - Testing

3. Service hydraulic retarders
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustment
   - Testing
   - Scheduled maintenance
Line Q:  SERVICE POWER TRAIN COMPONENTS  
Competency:  Q-1  Describe Power Transfer Systems

Objectives  
1. The learner will be able to describe methods of transferring power 
2. The learner will be able to describe the principles of power transfer

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Review methods of transferring power | • Fluid  
• Shafts  
• Belts  
• Chains  
• Gears |
| 2. Review the principles of power transfer | • Gear ratios  
• Simple  
• Compound  
• Torque  
• Speed  
• Power flow  
• Truck  
• Crawler  
• Excavator  
• Loader  
• Gear types |
Line Q: SERVICE POWER TRAIN COMPONENTS

Competency: Q-2 Service Clutches

Objectives
1. The learner will be able to describe the principles and operation of clutches and related components
2. The learner will be able to troubleshoot and service clutches and related components

LEARNING TASKS

1. Describe principles and operation of clutches and related components
   - Friction
   - Types
   - Friction
   - Wet/dry
   - Single/multi-plate
   - Mechanical
   - Jaw
   - Magnetic
   - Components
   - Operation

2. Service clutches and related components
   - Inspection
   - Visual
   - Linkage wear
   - Heat damage
   - Measure
   - Wear
   - Flywheel and housing runout
   - Removal
   - Replacement
   - Adjustment
   - Lubrication
   - Scheduled maintenance

3. Troubleshoot clutches and related components
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
**Line Q: SERVICE POWER TRAIN COMPONENTS**

**Competency:** Q-3 Service Standard Transmissions

### Objectives
1. The learner will be able to describe the operation of standard transmissions
2. The learner will be able to troubleshoot and service standard transmissions

### LEARNING TASKS

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe principles and operation of standard transmissions</td>
<td>• Types</td>
</tr>
<tr>
<td></td>
<td>• Manual shift</td>
</tr>
<tr>
<td></td>
<td>• Semi-automatic shift</td>
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<tr>
<td></td>
<td>• Fully-automatic shift</td>
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<td></td>
<td>• Components</td>
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<td></td>
<td>• Transmission Operation</td>
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<tr>
<td></td>
<td>• Shifting operation</td>
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<tr>
<td></td>
<td>• Mechanical</td>
</tr>
<tr>
<td></td>
<td>• Pneumatic</td>
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<tr>
<td></td>
<td>• Electrical/electronic</td>
</tr>
<tr>
<td></td>
<td>• Lubrication</td>
</tr>
<tr>
<td>2. Troubleshoot standard transmission</td>
<td>• Diagnostic procedures</td>
</tr>
<tr>
<td></td>
<td>• As per Competency C-9</td>
</tr>
<tr>
<td></td>
<td>• Diagnostic codes</td>
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<tr>
<td></td>
<td>• Road test</td>
</tr>
<tr>
<td></td>
<td>• Inspection</td>
</tr>
<tr>
<td></td>
<td>• Components and controls</td>
</tr>
<tr>
<td></td>
<td>• Testing</td>
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<tr>
<td>3. Service standard transmissions</td>
<td>• Inspection</td>
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<tr>
<td></td>
<td>• Remove</td>
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<tr>
<td></td>
<td>• Repair/replace</td>
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<td></td>
<td>• Install</td>
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<td></td>
<td>• Adjustment</td>
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<td></td>
<td>• Lubrication</td>
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<td></td>
<td>• Testing</td>
</tr>
<tr>
<td></td>
<td>• Diagnostic code</td>
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<td></td>
<td>• Scheduled maintenance</td>
</tr>
</tbody>
</table>
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-4 Service Drive Lines

Objectives
1. The learner will be able to describe drive lines and their components
2. The learner will be able to troubleshoot and service drive lines and their components

LEARNING TASKS

1. Review drive lines and components
   - Types
   - Components
   - Operation

2. Troubleshoot drive lines and components
   - Diagnostic procedures
   - As per Competency C-9
   - Inspection
   - Road test
   - Components
   - Measuring

3. Service drive lines and components
   - Phasing
   - Alignment
   - Remove
   - Inspection
   - Repair/replace
   - Install
   - Adjustment
   - Lubrication
   - Testing
   - Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-5 Service Drive Axles

Objectives
1. The learner will be able to describe the principles and operation of drive axles
2. The learner will be able to troubleshoot and service drive axles

LEARNING TASKS
1. Describe principles and operation of drive axles
   - Types
   - Single axle
   - Tandem axle
   - Tridem axle
   - Components
   - Differentials
   - Axle shafts
   - Traction devices
   - Inter axle differentials
   - Multi-speed
   - Controls and circuits
   - Mounting
   - Operation
   - Lubrication

2. Troubleshoot drive axles
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection
   - Testing

3. Service drive axles
   - Visual inspection
   - Fluid levels
   - Leaks
   - Mounting of attachments
   - Check operation
   - Remove
   - Pre-inspection
   - End play
   - Backlash
   - Patterns
   - Repair or replace
   - End play
   - Backlash
   - Patterns
   - Install
   - Adjustments
   - Lubrication
   - Testing
   - Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-6 Service Wheel Machine Final Drive

Objectives
1. The learner will be able to describe the principles and operation of machine final drives and hubs
2. The learner will be able to troubleshoot and service wheel machine final drives

LEARNING TASKS
1. Review operation of wheel machine final drives and hubs
   - Types
   - Components
   - Operation

2. Troubleshoot clutches and related components
   - Diagnostic procedures
   - As per Competency C-9
   - Operational test
   - Components
   - Inspection

3. Service wheel machine final drives
   - Inspection
   - Remove
   - Repair/replace
   - Install
   - Adjustments
   - Lubrication
   - Operational test
   - Scheduled maintenance
Program Content
Level 4

Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-7 Service Torque Converters/Dividers

Objectives
1. The learner will be able to describe the purpose of torque converters and dividers
2. The learner will be able to troubleshoot and service torque converters and dividers

LEARNING TASKS

1. Review the purpose of torque converters/dividers
   - Types
   - Components
   - Fluids
   - Diagnostic procedures
   - As per Competency C-9

2. Troubleshoot torque converters/dividers
   - Operational tests
   - Inspection
   - Testing
   - Stall
   - Cool down
   - Pressure

3. Service torque converters/dividers
   - Check operation
   - Visual inspection
   - Fluid levels
   - Leaks
   - Mounting of attachments
   - Removal
   - Installation
   - Filter/screens
   - Oil coolers
   - Scheduled maintenance
Line Q: SERVICE POWER TRAIN COMPONENTS
Competency: Q-8 Service Power Shift and Automatic Transmissions

Objectives
1. The learner will be able to describe the operation of power shift and automatic transmissions
2. The learner will be able to troubleshoot and service power shift and automatic transmissions

LEARNING TASKS
1. Describe the operation of power shift and automatic transmissions
2. Troubleshoot power shift and automatic transmissions
3. Service power shift and automatic transmissions

CONTENT
- Types
- Spur gear
- Planetary
- Construction
- Operation
- Diagnostic procedures
- As per Competency C-9
- Operational test
- Components
- Inspection
- Inspection
- Removal
- Replacement
- Adjustment
- Lubrication
- Scheduled maintenance
Line (R): SERVICE AIR CONDITIONING SYSTEMS
Competency: R-1 Describe the Fundamentals of Air Conditioning

Objectives
1. The learner will be able to identify air conditioning system components
2. The learner will be able to describe the construction and operation of air conditioning systems

LEARNING TASKS

1. Describe principles of air conditioning systems
2. Identify components of air conditioning systems
3. Describe the design and operation of air conditioning systems

CONTENT
- Describe the Law’s of thermodynamics
- Compressor
- Drive systems
- Evaporator
- Condenser
- Receiver-drier/accumulator
- Orifice tubes/expansion valves
- Refrigerant
- Lubricants
- Controls
- Sensors
- Hoses, piping and connectors
- Seals and gaskets
- Refrigerated cycle
- Compressor
- Evaporation
- Condenser
- Receiver-drier/accumulator
- Orifice tubes/expansion valves
- Refrigerant
- Lubricant
- Controls
- Sensors
Line (R): SERVICE AIR CONDITIONING SYSTEMS
Competency: R-2 Service Air Conditioning Systems

Objectives
1. The learner will be able to troubleshoot and service air conditioning systems

LEARNING TASKS

1. Troubleshoot air conditioning systems
   • Diagnostic procedures
   • As per Competency C-9
   • Operational test
   • Diagnostic codes
   • Components
   • Inspection
   • Testing

2. Service air conditioning systems
   • Inspection
   • Visual
   • Audible
   • Smell
   • Testing
   • Vacuum
   • Electrical
   • Mechanical
   • Leak detection methods
   • Evacuation and recharging
   • Environmental considerations
   • Removing and replacing components
Objectives

1. The learner will be able to describe the impact of CFC’s on the environment
2. The learner will be able to apply legislated procedures when dealing with systems containing CFC’s
3. The learner will pass the certification exam for CFC handling
4. The learner will pass the certification exam for retrofitting (R-12 to R134A)

LEARNING TASKS

1. Describe the impact of CFC’s on the environment
   • Ozone depletion
   • International
   • Montreal Protocol on substances that deplete the Ozone layer
   • Kyoto protocol to the United Nations framework Convention on Climate Change
   • Canadian Environmental Protection Act
   • Provincial regulations
   • Ozone depletion substances and other Halocarvon regulations
   • Waste Management Act
   • Training requirements
   • Environmental Awareness training course on ozone depleting substances control
   • Certification
   • CFC handling
   • Retrofit R-12 to R-134A
   • Conservation objectives

2. Identify legislation/agreement dealing with the use and handling of CFCs
   • Code of practice for the reduction of Chlorofluorocarbon Emissions from refrigerated and air conditioning systems
   • Service updates
   • Inventory assessment and record keeping
   • Design and general practice
   • Equipment
   • Refrigerant
   • Recovery
   • Reuse
   • Recycle
   • Reclalm
   • Leak testing procedures
   • Flushing and cleaning
   • Purging equipment, containers
   • Conversion and retrofitting
   • Testing and repair practices

3. Describe and apply procedures to be followed when dealing with systems containing CFCs
4. Obtain CFC and retrofitting certification

- CFC handling
- Retrofitting R-12 to R-134A
Section 4

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 and 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

Required Shop Tools and Equipment

- 3/4 – 1 inch torque wrench
- air line adapter
- alignment tool
- analyzer: gas, infrared, vibration meter
- battery charger
- battery load/starting system tester
- bearing heater
- black light
- bleeding equipment
- booster cable
- butane torch
- caliper: outside, inside
- chisel: air, electric, hand
- component heating or cooling equipment
- computer, portable diagnostic computer
- printer
- container
- continuity tester
- cooling system pressure tester
- crack detecting equipment
- crimping tool
- cutting and welding torch set
- cylinder cart and tank
- diagnostic equipment
- drift
- drill: bench, hand drivers, twist, air
- extension cord/trouble light
- fast charger
- file
- flaring tool
- flushing kit
- fuel quality test kit
- fuel recovery and storage system
- funnel
- graduated vessel
- grease gun
- grinder: bench, hand, valve
- hand pump
- harness tester
- honing equipment
- hot air gun
- labelling kit
- leak detection equipment
- level protractor
- nitrogen charging equipment
- press: arbor, spring, hydraulic, bushing, shop, mechanical
• pry bar
• puller: bearing, gear, heavy duty, reamer
• refrigerant recycling cart
• refractometer
• retrieval and storage equipment
• sander
• saw: jigsaw, hacksaw, hole saw
• scanning tool
• seal driver
• shop vacuum
• soldering iron/gun
• spark lighter
• steering wheel puller
• straight edge
• strobe light
• stud extractor
• suction cups
• tachometer
• tap and die set
• temperature gauge
• thermostat tester
• thread file
• tire bar
• tire tread depth gauge
• torque angle tool, torque wrench
• torque multiplier
• tube bender
• vacuum pump
• valve spring tester
• vice
• welding equipment
• Safety Equipment
• Apron

Required Safety Equipment

• ear protection
• 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
• ladder
• leather gloves
• leggings
- manlift
- respirator
- safety boots
- safety cage
- safety glasses
- safety hat
- splash suit

**Required Hoisting, Rigging and Holding Equipment**

- axle stand
- bottle/axle jack
- cable hoist
- chain hoist
- clamp
- clevis
- dolly
- floor hoist
- forklift
- ground strap
- hydraulic floor jack
- hydraulic guard
- hydraulic hand jack
- hydraulic transmission jack
- repair stand
- shim/blocking
- shop crane
- sling/cable/chain
- spreader bar
- support stand
- tire guard
- transmission jack
- vice

**Recommended Cleaning Equipment**

- air blowgun
- brake cleaning equipment
- cleaning cloth
- cleaning gloves
- crocus cloth
- glass bead machine
- hot tank degreaser
- parts cleaning solvent
- pressure washer
- soft brush
- solvent washer
Recommended Measuring Tools, Gauges and Equipment

- air pressure gauge
- ammeter
- belt tension gauge
- boost gauge
- borescope
- depth micrometer
- dial gauge
- electric pressure gauge
- flowmeter
- fuel pressure gauge
- holding gauge
- hydraulic pressure testing gauge/fittings
- hydrometer
- inside micrometer
- level
- manifold gauge
- mechanical pressure gauge
- non-magnetic feeler gauge
- oil temperature gauge
- phototachometer
- pressure gauge
- pull-type scale
- pyrometer
- small hole gauge
- spectroscope
- spring scale
- steel ruler
- stethoscope
- straight edge
- tachometer
- telescoping gauge
- test light
- thermometer
- timing gauge
- tire gauge
- transmission gauge set
- vacuum gauge
- coolant recycling unit
- mobile crane

Recommended Facility Tools

- air compressor
- chemical agitator
Required Student Equipment (supplied by school)

- 1/4, 3/8, and 1/2 inch drive socket sets
- adjustable wrench
- bar (pry, aligning, heel)
- battery post and clamp cleaner, battery
- terminal nut
- battery terminal puller
- brass drift
- center punch
- chisel
- wire cutter, plier cutters, shears
- digital multimeter
- feeler gauge set
- file
- hacksaw and blade
- hammer: impact, rubber, sledge, air, slide, soft blow
- hex key set, metric and imperial
- 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
- wrench set, combination (metric & imperial)
- wrench set, flare nut (metric & imperial)

Required Safety Equipment for Student (supplied by student)

- Coveralls
- Safety boots
- Safety glasses
Reference Materials

Recommended Resources

ELTT – Module 1
- Heavy Duty ELTT Learning Guides CPUB - 035M
- Engines, ISBN: 0-86691-246-0
- BC Air Brake Manual
- Common Core Math Modules or Math for the Automotive Trade (Peterson and Dekryger), ISBN: 0-8273-6712-0
- Industrial Health and Safety Regulations (Free From WCB)

Level 1
- Heavy Duty Year 1 Apprenticeship Learning Guides - Optional
- BC Air Brakes Manual
- Inside Air Brake Valves and Devices (Allen C. Wright)
- F.O.S. Electronic and Electrical Systems
- CVIP Manuals - Optional

Level 2
- Heavy Duty Year 2 Apprenticeship Learning Guides
- Diesel Technology (Norman/Scarff/Cosinchock) ISBN: 1-56637-014-0

Level 3
- Heavy Duty Year 3 Apprenticeship Learning Guides
- Diesel Technology (Norman/Scarff/Cosinchock) ISBN: 1-56637-014-0
  or

Level 4
- Heavy Duty Year 4 Apprenticeship Learning Guides
- F.O.S. Air Conditioning (Deere), ISBN: 0-86691-221-5 – Optional
Instructor Requirements

Occupation Qualification
The instructor must possess:
- BC Certificate of Qualification in the related trade

Work Experience
A minimum of 10 years experience working in the industry as a journeyperson.
Completion of trade related apprenticeship is preferred.

Instructional Experience and Education
It is preferred that the instructor also possesses:
- Grade 12 or equivalent
- Instructor Diploma