ONTARIO COLLEGE OF TRADES

ORDRE DES MÉTIERS DE L'ONTARIO

Apprenticeship Curriculum Standard

Powered Lift Truck Technician

Level 2

Trade Code: 282E

Date: 2010

Please Note: Apprenticeship Training and Curriculum Standards were developed by the Ministry of Training, Colleges and Universities (MTCU). As of April 8th, 2013, the Ontario College of Trades (College) has become responsible for the development and maintenance of these standards. The College is carrying over existing standards without any changes.

However, because the Apprenticeship Training and Curriculum Standards documents were developed under either the *Trades Qualification and Apprenticeship Act* (TQAA) or the *Apprenticeship and Certification Act, 1998* (ACA), the definitions contained in these documents may no longer be accurate and may not be reflective of the *Ontario College of Trades and Apprenticeship Act, 2009* (OCTAA) as the new trades legislation in the province. The College will update these definitions in the future.

Meanwhile, please refer to the College's website (http://www.collegeoftrades.ca) for the most accurate and up-to-date information about the College. For information on OCTAA and its regulations, please visit: http://www.collegeoftrades.ca/about/legislation-and-regulations

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Introduction

The Powered Lift Truck Level 2 (PLT) curriculum has been developed in keeping with the prescribed Ministry of Training, Colleges and Universities (MTCU) Training Standards. The curriculum layout used provides an opportunity to cross-reference th in-school learning outcomes and content to the specific workplace Training Standards.

For easy reference, a time allocation has been included for each reportable subject, along with the Theory/Practical breakdown for the delivery of the Learning Content. More detailed time allocations for the instructor have been provided for each topic area to assure consistency for each apprentice intake.

The continual introduction of innovative techniques and more complex equipment is resulting in increasing demands for tradespersons who are not only skilled in the practical aspects of the trade, but who also have a sound theoretical knowledge of the inspecting, diagnosing, repair, and servicing requirements. The curriculum has been developed to provide this theoretical knowledge and to offer some practical applications to complement the on-the-job work experiences of the Powered Lift Truck apprentices.

The objective of the curriculum, therefore, is to provide a basis for:

a. Sound theoretical training that meet the challenges presented by the increasingly more complex equipment designs and testing techniques.
b. A reinforcement of fundamental skills of the trade through the exposure to practical applications.
c. Developing in the apprentices high standards of craftsmanship, problem-solving skills, and personal pride in their trade.
d. Developing desirable work attitudes and a keen sense of responsibility, particularly concerning public and personal safety.

The curriculum has been designed to give the instructor every reasonable opportunity for flexibility and innovation without deviating to any significant degree from the subject requirements, as determined by the Industry Committees and as prescribed in the Regulations for the Trades. Since the scope of the prescribed curriculum is quite extensive, the apprentices must be expected to reinforce the acquired knowledge through regular independent out-of-classroom assignments. The curriculum has been presented in a chronological sequence in keeping with sound teaching methodologies. However, the actual application of the sequence may differ somewhat between colleges because of scheduling, staffing, and facilities utilization.

The curriculum includes specific references to the Ministry of Training, Colleges and Universities Apprenticeship Training Standards. While these references to various performance objectives in the Training Standards have been linked to the respective in-school outcomes, employers should not assume complete coverage to a journeyperson level. The in-school delivery focuses primarily on the knowledge required to master the respective objectives outlined in the Training Standards. Employers, therefore, are expected to complete the training of these respective objectives by applying the prescribed in-school knowledge to the required practical learning experienced in the work setting.

To ensure that apprentices will be able to successfully demonstrate the learning outcomes according to performance criteria, specific times have been allocated in the respective areas to allow for some applications enhancement. It is of utmost importance that all application assignments relate to prescribed experiences only. Time constraints will not permit engaging apprentices in tasks of limited learning benefit that are unrelated to the curriculum outcomes. In the Learning Content section, whenever an assigned operation for an applied test or repair procedure indicates that a demonstration should be performed, there is only enough time allocated for the instructor to perform the activity.

Regular evaluations of the apprentices' learning achievements must be performed in both theory and practical applications throughout the program to ensure consistency with learning outcome expectations. Testing of apprentice knowledge and skills will take place during the allotted delivery hours for each unit. In addition to providing an evaluation of apprentice competency, the review of test question answers is considered to be a valuable learning opportunity.

In all practical activities, the apprentices will observe the Occupational Health and Safety Act and the applicable regulations including use of personal protective equipment. Institutional regulations and policies may also apply.

Participation by Stakeholders

A consortium of six colleges of applied arts and technology, working in collaboration with the Ministry of Training, Colleges and Universities and industry stakeholders, participated in the development of this document. The development and subsequent revisions were based on the training standards that were previously revised by the MTCU in consultation with industry advisory groups. The development was completed using a process and format approved by MTCU.

Participating Colleges

- Cambrian College of Applied Arts and Technology (Project Lead)
- Algonquin College of Applied Arts and Technology
- Centennial College of Applied Arts and Technology(PLT Level 2 lead)
- Fanshawe College of Applied Arts and Technology
- Mohawk College of Applied Arts and Technology
- Sault College of Applied Arts and Technology

Industry Representatives:

Equipment World Ltd
Sudbury Truck & Trailer Ltd
Toromont CAT Ltd
Nortrax Ltd
Xstrata Nickel Ltd
McGavin Farm Equipment Ltd.
Elmira Farm Service Ltd
Liftow Inc.
Vale Inco Ltd
Volvo Canada Ltd
Atlas Copco Construction & Mining Canada Ltd

The first step in the development process was to assemble a Project Steering Committee (PSC), consisting of both industry representatives and apprenticeship in-school deliverers. The PSC initiated the plan for the project development that followed. The PSC established six working teams, each responsible for the development of in-school apprenticeship curriculum documents for the specific motive power trades listed below:

- Level 1 common to Agricultural Equipment, Heavy Duty Equipment, Powered Lift Truck, and Truck and Coach
- Level 2 common to Agricultural Equipment and Heavy Duty Equipment
- Level 3 specific to Agricultural Equipment
- Level 3 specific to Heavy Duty Equipment
- Level 2 and 3 specific to Powered Lift Truck
- Level 2 and 3 specific to Truck and Coach

The six teams worked with advisory groups during the development of the curriculum. The advisory groups were industry representatives who ensured content validity. During various stages of the process, the PSC and participating industry advisory groups evaluated the draft curriculum documents and provided feedback and recommendations for revisions.

Power Lift Truck Technician

Level 2

Program Summary of Reportable Subjects - Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S1269	Trade Practices	16	10	6
S1270	Electrical Systems	40	24	16
S1271	Computer Control Systems	16	10	6
S1272	Fuel Systems	16	12	4
S1273	Engine Systems	32	16	16
S1274	Chassis Systems	32	20	12
S1275	Frame, Drive, and Lift Systems	48	31	17
S1276	Hydraulic Systems	40	27	13
	Total	**240**	**150**	**90**

Number: **S1269**

Reportable Subject: **TRADES PRACTICES**

Duration: Total 16 hours Theory 10 hours Practical 6 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

1.1 Occupational Health and Safety

4 Total Hours Theory: 3 hours Practical: 1 hour

1.2 Vehicle Identification

4 Total Hours Theory: 4 hours Practical: 0 hours

1.3 Electric ARC Welding Practices

8 Total Hours Theory: 3 hours Practical: 5 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Power Lift Truck Data Plates/ Attachment Plates	Arc Welding Equipment
Welding Safety Equipment	

S1269.1 Occupational Health and Safety

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard: **PLTT** 5860

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice will be able to understand the Occupational Health and Safety Act and safety procedures; workplace related standards, and shop safety procedures.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.1.1 Describe the legal responsibilities of the powered lift truck technician in accordance with government legislation for relevant workplace activities.

[3/0] - **develop a working knowledge of the *Guidelines for the Safe Operation and Maintenance of Powered Lift Trucks* (Reference ISBN 0-7778-8974-9, July 1999)**

1.1.2 Identify the procedures following manufacturers' recommendations and government regulations for performing a safety inspection on a powered lift truck.

[0/1] **demonstrate a visual inspection procedure for:**

- **lifting systems**
- **braking systems**
- **specification plates**
- **steering systems**
- **safety fail safe systems**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protections
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - potential lifting hazards
  - high pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1269.2 Vehicle Identification

Duration: Total 4 hours Theory 4 hours Practical 0 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard: **PLTT** 5860.05

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to interpret a powered lift truck vehicle identification number (VIN) and apply service-related information.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.2.1 Describe the purpose and fundamentals of a powered lift truck data plates.

[1/0] - **interpretation of specific manufactures' information**

1.2.2 Identify how to interpret the information on a powered lift truck data plate.

[2/0]
- **load rating**
- **truck model and serial number**
- **gross vehicle weight (GVW)**
- **attachments**
- **battery specifications**
- **minimum/maximum battery weight**
- **voltage**
- **tilt angles**
- **tire specifications**
- **tread width**
- **Modifications**
- **U.L.C. rating (Underwriters Laboratory Canadian)**

1.2.3 Explain the principles of interpreting the information on a powered lift truck data plate.

[1/0]
- **load rating and tilt angles**
  - geometry
  - trigonometry
  - physics
    - o laws of leverage
  - attachments
  - minimum/maximum battery weight

  tread width
- **load rating**
  - GVW

- **electrical specifications**
- **tire specifications**
- **modifications**
- **U.L.C. Rating (Underwriters Laboratory Canadian)**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1269.3 Electric Arc Welding Practices

Duration: Total 8 hours Theory 3 hours Practical 5 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard: **PLTT** 5860

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to perform electric arc welding procedures following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.3.1 Describe the purpose and fundamentals of electric arc welding.

[1/0]
- **electricity**
- **electrical circuit theory**
- **transformers**
- **rectifiers**
- **basic metallurgy**

1.3.2 Identify the construction features, and application of electric arc welding equipment.

[1/0]
- **alternating current (AC) welding transformers**
- **direct current (DC) rectifiers**
  - straight polarity
  - reverse polarity
- **arc welding cables**
- **electrode holders**
- **American Welding Society (AWS) electrode classification**

1.3.3 Describe the principles of operation for electric arc welding equipment and techniques.

[1/0]
- **AC welding transformers**
- **DC rectifiers**
- **open circuit voltage**
- **closed circuit voltage**
- **electrode coding interpretation**
- **weld characteristics of electrode types**
- **destructive and non-destructive weld testing**
- **analysis of welds**
- **techniques of positional welding**

1.3.4 Perform assigned electric arc welding tasks.

[0/3]
- **electrode selection**
- **equipment set-up**
  - electric arc welding on mild steel
- **lap welds**
- **fillet welds**
- **butt welds**
- **positional welding techniques**

1.3.5 Recommend repairs following manufacturers' recommendations using electric arc welding equipment.

[0/2] **perform a demonstration of the following:**
- **identify personal arc welding safety equipment requirements**
- **identify high voltage electrical safety hazards**
- **identify types of steel by testing and application**
- **analyze the cause of failed welds**
- **review requirements for structural and repair welds**
- **identify pressure vessels and non-repairable components**
- **review explosion hazards safety**
- **outline the procedure to protect electronic and mechanical components from arcing damage**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - eye, hearing, face, and clothing protection
  - fire prevention
  - ventilation
  - cut and burn treatments
  - flammable container welding precautions
  - electrical shock protection
  - vehicle electronic protection
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1270**

Reportable Subject: **ELECTRICAL SYSTEMS**

Duration: Total 40 hours Theory 24 hours Practical 16 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

2.1 Electric Lift Truck Batteries

10 Total Hours Theory: 5 hours Practical: 5 hours

2.2 DC Electric Motor Systems

18 Total Hours Theory: 11 hours Practical: 7 hours

2.3 Cranking Circuits

6 Total Hours Theory: 4 hours Practical: 2 hours

2.4 Electrical Circuit Schematics

6 Total Hours Theory: 4 Hours Practical: 2 Hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
65%	35%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
Equipment Service Manuals

Recommended Minimum Equipment:

Electric Powered Lift truck	Battery Lifting Equipment
Hydrometer	Multimeter
Carbon Pile	Electric Lift Truck
PPE	OEM Schematics
DC Motor Switching Panel	Starter Motor Assemblies
IC Engine With Starter	

S1270.1 Electric Lift Truck Batteries

Duration: Total 10 hours Theory 5 hours Practical 5 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5872.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend repairs or replacement following manufacturers' recommendations of electric lift truck batteries.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.1.1 Describe the purpose and fundamentals of electric lift truck batteries.

[1/0]
- **fundamentals enhancement**
- **battery discharge curves**

2.1.2 Describe the construction features and composition of electric lift truck batteries.

[1/0]
- **flat plate**
- **tubular**
- **gel**

2.1.3 Identify the principles of operation of electric lift truck batteries.

[1/0]
- **battery chemical action during charging and discharging cycles**
- **flat plate**
- **tubular**
- **gel**

2.1.4 Perform the procedures to safely remove and install electric lift truck batteries.

[0/2]
- **safe hoisting procedure**
  - personal protective equipment
  - slings and rigging
  - O.E.M. approved devices
- **safe rolling procedure**
  - O.E.M. approved devices

2.1.5 Perform the procedure for the routine charging of electric lift truck batteries.

[0/1]
- **charging cycles**
- **intermittent**
- **continuous**

2.1.5 Perform inspection and testing procedures following manufacturers' recommendations for electric lift truck batteries.

[2/2]
- **perform a visual inspection for:**
  - leaks
  - cracks
  - distortion
  - cleanliness
- **measure open cell voltages**
- **measure positive and negative potential to chassis**
- **measure positive receptacle resistance to chassis**
- **measure negative receptacle resistance to chassis**
- **test individual cell voltage drops under load**
- **test for specific gravity**
  - hydrometer method
  - refractometer

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1270.2 DC Electric Motor Systems

Duration: Total 18 hours Theory 11 hours Practical 7 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5873.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend replacement or repairs of DC electric motor systems following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.2.1 Describe the purpose and fundamentals of direct current electric motor systems.

[1/0] - **DC electrical motor fundamentals**
- permanent magnets
- electromagnetism
- counter-electromotive force
- centrifugal force
- voltage drops of high current circuits
- vibration control
- thermal protection
- cable requirements
- field windings
- armature
- commutator
- brushes
- springs

- **DC motor circuit analysis**

2.2.2 Identify the function, construction features, and composition of direct current electric motor systems.

[2/0] - **direct current motor types**
- series wound
- shunt wound
- cumulative compound
- differential compound
- permanent magnet
- motor controllers
  - resistor control (rheostat)
  - silicon control rectifier
  - transistor chopper
  - directional switching devices
  - mechanical

2.2.3 Explain the principles of operation of direct current electric motor systems and components.

[6/2] - **direct current motor types**
- series wound
- shunt wound
- cumulative compound
- differential compound
- permanent magnet

- **motor controllers**
- resistor control (rheostat)
- silicon control rectifier
- transistor chopper
- directional switching devices
  - mechanical
  - electronic

2.2.4 Perform inspection and testing procedures following manufacturers' recommendations for direct current electric motor systems and components.

[0/3] - **perform a visual inspection**

- **perform service ability testing procedures for:**
- continuity
- current draw
- voltage drop
- bench testing
- insulation stress test

- **perform component failure analysis**

2.2.5 Recommend reconditioning or repairs following manufacturers' recommendations for operations of direct current electric motor systems.

[2/2]
- **perform maintenance procedures**
- **perform disassembly and reassembly procedures of direct current electric motors**
- **outline the procedures to remove and replace direct current electric motors and components**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1270.3 Cranking Circuits

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5862.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to perform diagnostic and testing procedures of powered lift truck electrical starting and charging systems and related components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.3.1 Describe and identify the purpose and fundamentals of powered lift truck cranking circuits.

[2/0]
- **voltage drops of high current circuits**
- **relays**
- **solenoids**
- **drives**

2.3.2 Explain the principles of operation of powered lift truck cranking circuits.

[2/0]
- **relays**
- **solenoids**
  - hold-in winding
  - pull-in winding
- **drives**
  - overrunning clutch
  - disengagement protection

2.3.3 Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations for powered lift truck cranking circuits.

[0/1]
- **outline the recommended diagnostic sequence for cranking system malfunction**
- **perform cranking circuit current draw and voltage drop tests**
- **demonstration of cranking no-load bench test**
- **demonstration of relay and solenoid testing**

- **perform component failure analysis checking for:**
  - wear
  - overheating
  - opens, shorts, and grounds
  - drive defects

2.3.4 Recommend reconditioning or repairs following manufacturers' recommendations on powered lift truck cranking circuits.

[0/1]
- **outline the procedures to remove and replace a cranking motor and perform ring gear inspection**
- **outline effects of cranking motor misalignment and improper drive tooth contact**
- **outline the removal and replacement procedures for relays and solenoids**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - eye, hearing, breathing and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1270.4 Electrical Circuit Schematics

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5873.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to interpret the electrical schematics produced by powered lift truck manufacturers and perform circuit calculations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.4.1 Explain the purpose and fundamentals of electrical circuit schematics.

[2/0]
- **electricity**
- **electronics**
- **series circuits**
- **parallel circuits**
- **series-parallel circuits**
- **electrical schematics**
  schematic symbols
- **OEM electrical schematics**
- **digital schematics**
- **Valley Forge**
- **SAE and DIN schematics**

2.4.2 Describe the principles used to develop different types of electrical circuit schematics.

[2/0]
- **circuit calculations**
  - current flow
  - voltage drop
  - resistance factors
  - power calculations (wattage)

2.4.3 Perform calculations and circuit analysis using electrical circuit schematics and verify on powered lift equipment.

[0/2]
- **perform circuit analysis using OEM schematics**
- **test operational and malfunctioning electrical circuit components**
- **diagnose common circuit malfunctions**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - eye, hearing, breathing, and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronics format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1271**

Reportable Subject: **Computer Control Systems**

Duration: Total 16 hours Theory 10 hours Practical 6 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

3.1 Vehicle Management Computers

10 Total Hours Theory: 6 hours Practical: 4 hours

3.2 Sensors

6 Total Hours Theory: 4 hours Practical: 2 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
65%	35%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:

Recommended Minimum Equipment:

IC Lift Truck	Electric Lift Truck
Computer with Appropriate Software and Hardware	Multimeter
Scan-tool	

S1271.1 Vehicle Management Computers

Duration: Total 10 hours Theory 6 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5865

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend replacement or repairs to vehicle management computers and related systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.1.1 Describe the purpose and fundamentals of vehicle management computers.

[1/0]
- **computers**
- **digital electronics**
- **input and output circuits**

3.1.2 Identify the functions, construction features, composition, types, styles, and application for vehicle management computers.

[2/0]
- **ECM housings**
- **microprocessors**
- **input circuit devices**
- **switching apparatus**
- **multiplexed ECMs**
- **interface modules**

3.1.3 Explain the principles of operation of vehicle management computers.

[3/0]
- **input conditioning**
- **analogue to digital conversion**
- **CPUs**
- **RAM**
- **non-volatile RAM (NV-RAM)**
- **cache**
- **ROM**
- **PROM/personality module**
- **EEPROM**
- **processing cycle**

3.1.4 Perform common diagnostic procedures following manufacturers' recommendations for electronically managed vehicle systems.

[0/2]
- **data programming**
- **using ESTs to diagnose problems**
- **correlating fault codes to actual problems**
- **software guided troubleshooting**
- **accessing OEM data hubs**

3.1.5 Recommend reconditioning or repairs following manufacturers' recommendations for electronically managed vehicle systems.

[0/2]
- **outline electric wire terminal repair procedure**
- **demonstrate electronic module replacement procedures**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - eye, hearing, breathing, and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronics format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1271.2 Sensors

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5865

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend replacement or repairs to sensors and related components.

LEARNING OUTCOMES AND CONTENT

3.2.1. Upon successful completion, the apprentice is able to explain the operation and function of vehicle sensors.

[4/2]
- **reluctor**
- **hall effect**
- **optical**
- **peizo resistive**
- **thermistor**
- **yaw sensor**
- **potentiometer**
- **proximity**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - applied safety precautions
  - eye, hearing, breathing and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1272**

Reportable Subject: **FUEL SYSTEMS**

Duration: Total 16 hours Theory 12 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

4.1 Gasoline Fuel Systems

6 Total Hours Theory: 4 hours Practical: 2 hours

4.2 LPG Fuel Systems

4 Total Hours Theory: 3 hours Practical: 1 hour

4.3 Compressed Natural Gas (CNG) Fuel Systems

3 Total Hours Theory: 2 hours Practical: 1 hour

4.4 Dual and Alternative Fuel Systems

3 Total Hours Theory: 3 hours Practical: 0 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
75%	25%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

IC Lift Trucks	LPG, CNG Cylinder or equivalent training aids
LPG, CNG mixers and Regulators	Dual Fuel System and Components

1272.1 Gasoline Fuel Systems

Duration: Total 7 hours Theory 4 hours Practical 3 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5864.02

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to outline the diagnostic and repair procedures of gasoline fuel systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.1.1 Describe the purpose and fundamentals of gasoline fuel systems.

[1/0]
- **fuel chemistry**
- **Otto cycle**
- **fuel sub-system**
- **PFI**
- **TBI**

4.1.2 Identify the construction features of gasoline fuel systems and components.

[1/0]
- **fuel tanks**
- **filters**
- **pumps**
- **fuel rail**
- **injectors**
- **throttle bodies**
- **exhaust gas sensors**
- **regulators**
- **vacuum and pressure switches**

4.1.3 Explain the principles of operation of gasoline fuel systems and components.

[2/0]
- **fuel sub-systems**
- **fuel rail**
- **sequential port injection**
- **injectors**
- **throttle bodies**

- **regulators**
- **open and closed loop cycles**
- **emission controls**

4.1.4 Perform testing and diagnostic procedures following manufacturers' recommendations for gasoline fuel systems and components.

[0/2]
- **perform a demonstration of the testing procedures for:**
  - fuel tanks
    - visual inspection
  - filters
  - fuel rail
  - injectors
  - throttle bodies
  - sensors
  - regulators
- **perform a demonstration of the diagnostic procedures for:**
  - fuel leaks
  - fuel injection system failures

4.1.5 Recommend reconditioning or repair procedures following manufacturers' recommendations for gasoline fuel systems.

[0/1]
- **reference manufactures and legislative safety standards**
- **demonstrate the removal and replacement procedures for:**
  - fuel tanks
  - fuel filters
  - injectors
  - sensors

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1272.2 LPG Fuel Systems

Duration: Total 5 hours Theory 4 hours Practical 1 hour

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5864.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to outline the diagnostic and repair procedures of LPG fuel systems following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.2.1 Describe the purpose and fundamentals of LPG fuel systems.

[1/0]
- **fuel storage cylinders**
- **fuel sub-system**

4.2.2 Identify the construction features of LPG fuel systems.

[1/0]
- **fuel storage cylinders**
- **filters**
- **vaporizers**
- **throttle bodies**
- **sensors**
- **regulators**
- **vacuum and pressure switches**

4.2.3 Explain the principles of operation of LPG fuel systems.

[2/0]
- **fuel storage cylinders**
- **filters**
- **vaporizers**
- **throttle bodies**
- **sensors**
- **regulators**
- **vacuum and pressure switches**
- **open and closed looping**

4.2.4 Perform the diagnostic and repair procedures to assess and improve the performance of an engine equipped with an LPG fuel system.

[0/1]
- **fuel storage cylinders**
- **vaporizers**
- **sensors**
- **regulators**
- **leak detectors**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1272.3 Compressed Natural Gas (CNG) Fuel Systems

Duration: Total 3 hours Theory 2 hours Practical 1 hour

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5864.08

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to understand the operating principles of compressed natural gas (CNG) fuel system components and be able to diagnose common problems and recommend repairs.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.3.1 Describe the purpose and fundamentals of CNG fuel systems.

[0.5/0]
- **fuel storage cylinders**
- **fuel sub-system**
- **filters**
- **vaporizers**
- **throttle bodies**
- **sensors**
- **regulators**
- **vacuum and pressure switches**

4.3.2 Identify the construction features of CNG fuel system components.

[0.5/0]
- **fuel storage cylinders**
- **filters**
- **vaporizers**
- **throttle bodies**
- **sensors**
- **regulators**
- **vacuum and pressure switches**

4.3.3 Explain the principles of operation of CNG fuel systems components.

[0.5/0]
- **fuel storage cylinders**
- **filters**
- **vaporizers**
- **throttle bodies**

- **sensors**
- **regulators**
- **vacuum and pressure switches**
- **open and closed looping**

4.3.4 Perform inspection and testing procedures following manufacturers' recommendations on CNG fuel systems and components.

[0.5/0] - **outline the inspection and testing procedures for:**
- fuel storage cylinders
- vaporizers
- sensors
- regulators
- leak detectors

4.3.5 Recommend reconditioning or repairs following manufacturers' recommendations for CNG fuel system components.

[0/1] - **reference manufacturers' and legislative safety standards**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1272.4 Dual and Alternate Fuel Systems

Duration: Total 3 hours Theory 3 hours Practical 0 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5864.08

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to explain the operating principles of dual fuel (gasoline and compressed gas) system components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.4.1 Describe the purpose and fundamentals of dual and alternate fuel systems.

[1/0]
- **fuel storage cylinders**
- **fuel sub-system routing**
- **mixing chambers**
- **fuel source controls**
- **filters**
- **pumps**
- **sensors**
- **regulators**
- **vacuum and pressure switches**
- **fuel source control**
- **vaporizers**
- **throttle bodies**
- **fuel source control device**

4.4.2 Identify the construction features of dual and alternate fuel systems.

[1/0]
- **fuel storage cylinders**
- **filters**
- **pumps**
- **regulators**
- **governors**
- **vaporizers**
- **throttle bodies**
- **vacuum and pressure switches**
- **fuel source control device**

4.4.3 Explain the principles of operation of dual and alternate fuel system components.

[1/0]
- **fuel storage cylinders**
- **filters**
- **pumps**
- **vaporizers**
- **throttle bodies**
- **sensors**
- **regulators**
- **vacuum and pressure switches**
- **open and closed looping**
- **fuel source control device**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1273**

Reportable Subject: **ENGINE SYSTEMS**

Duration: Total 32 hours Theory 16 hours Practical 16 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

5.1 Small Bore Engine Fundamentals

8 Total Hours Theory: 2 hours Practical: 6 hours

5.2 Engine Short Block Assemblies

15 Total Hours Theory: 9 hours Practical: 6 hours

5.3 Valve Train and Cylinder Heads Assemblies

9 Total Hours Theory: 5 hours Practical: 4 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
60%	40%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Precision Measuring Equipment	Engines and Components for teardown and reassembly

S1273.1 Small Bore Engine Fundamentals

Duration: Total 8 hours Theory 2 hours Practical 6 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5863

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to inspect and measure small bore engine components following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.1.1 Describe the fundamentals of small bore engine construction and design.

[0.5/0]
- **Otto cycle**
- **Diesel cycle**
- **four-stroke cycle**
- **thermal efficiency**

5.1.2 Identify the principles of operation of small bore internal combustion engines.

[0.5/0]
- **Otto cycle**
- **Diesel cycle**
- **four-stroke cycle**
- **thermal efficiency**

5.1.3 Explain and describe the role of all of the sub-circuits and systems of a small bore engine system.

[0.5/0]
- **cylinder block**
- **cylinder heads**
- **intake system**
- **exhaust system**
- **cooling system**
- **lubrication system**

5.1.4 Perform applied calculations to verify engine performance specifications.

[0.5/0]
- **swept volume**
- **piston displacement**
- **compression ratio**
- **compression pressure**
- **thermal efficiency**
- **power**

5.1.5 Perform inspection and measuring procedures following manufacturers' recommendations of small bore engine assemblies.

[0/3]
- **describe disassembly sequence and precautions**
- **mark connecting rod and main bearing caps**
- **identify moving and stationary engine components**
- **measure cylinder bore diameter, crankshaft journals, clearances and deck misalignment**
- **plastigage crankshaft bearings**
- **describe assembly sequence and torque sequence**
- **interpretation of manufacturers' literature**

5.1.6 Perform removal and installation procedures following manufacturers' recommendations for small bore engines from powered lift truck chassis.

[0/3]
- **chassis access**
- **body disassembly sequence**
- **lifting techniques**
- **storing and supporting components**
- **explain the procedures to remove and replace an engine**
- **draining of fluids**
- **replacement precautions**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1273.2 Engine Short Block Assemblies

Duration: Total 15 hours Theory 9 hours Practical 6 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5863.11

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to outline the inspection and measuring procedures for small bore engine cylinder blocks and related components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.2.1 Describe the purpose and fundamentals of engine cylinder block, piston assemblies, and connecting rods.

[1/0]
- **thermodynamics**
- **engine power production factors**
- **torque production and power flows**

5.2.2 Identify the function, construction features, composition, types, styles, and application of short block components.

[4/0]
- **cylinder blocks**
- **parent bores**
- **wet and dry sleeves (liners)**
- **cylinder wall surface finish**
- **pistons, pins and rings**
- **connecting rods**
- **crankshafts**
- **bearings**
- **harmonic balancers and flywheels**

5.2.3 Explain the operating principles of short block and engine power train components.

[3/0]
- **crank to throw vector angles**
- **compression and tension forces**
- **engine configuration**
- **power balance**

5.2.4 Perform inspection and testing procedures following manufacturers' recommendations on cylinder block and engine power train components.

[1/5]
- **general cleaning procedures with:**
  - solvents
  - equipment
- **perform cylinder ridge removal procedures**
- **cylinder block dismantling and assembly procedures**
- **visual inspection of engine short block and component assemblies**
- **measurements for:**
  - cylinder wear
  - block warpage
  - piston wear
  - piston ring end gap

5.2.5 Recommend reconditioning or repairs following manufacturers' recommendations on short block assemblies.

[0/1] **perform a demonstration of:**
- **de-glazing or honing a cylinder**
- **fitting pistons and piston pins**
- **removing, performing clearance checks, and installing piston rings**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

1273.3 Valve Train and Cylinder Head Assemblies

Duration: Total 9 hours Theory 5 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5863.10

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to test and verify repairs on small bore engine valve trains and camshafts.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.3.1 Define the purpose and fundamentals of camshaft and valve train assemblies used in small bore engines.

[1/0]
- **valve timing**
- **cylinder breathing**
- **interpret and draw valve timing diagram**

5.3.2 Identify the functions, construction features, types, and application of valve train drive mechanisms, valve trains, and camshaft assemblies.

[2/0]
- **camshafts (in-block and overhead)**
- **valve geometry**
- **bearings**
- **sprockets and gears**
- **thrust controls**
- **timing gear train**
  - gears
  - chains
  - belts

5.3.3 Explain the principles of operation of valve train and camshaft components and service equipment.

[2/0]
- **cam profile geometry**
- **valve train actuation**
- **valve timing and engine breathing**
- **cross-flow and parallel port breathing**
- **valve float**
- **valve dynamics**

5.3.4 Perform inspection and measuring procedures following manufacturers' recommendations on camshafts and valve trains drive mechanisms.

[0/2] - **demonstrate the following activities:**
- visual inspection
- measuring valves
- measuring camshafts
- identifying lobe, journal, and thrust wear
- checking camshaft warpage
- measuring bearing wear

5.3.5 Recommend reconditioning or repairs following manufacturers' recommendations on valve train and camshaft components.

[0/2] - **demonstration of removing and installing timing belts and chains**
- **outline the disassembly procedures**
- **adjust timing chains and belts**
- **valve lash adjustment on a variety of styles**
- **demonstration of valve train components failure analysis for:**
  - wear
  - fractures
  - distortion

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1274**

Reportable Subject: **CHASSIS SYSTEMS**

Duration: Total 32 hours Theory 20 hours Practical 12 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

6.1 Suspension Systems

14 Total Hours Theory: 8 hours Practical: 6 hours

6.2 Solid Wheels and Tires

6 Total Hours Theory: 3 hours Practical: 3 hours

6.3 Pneumatic Wheels and Tires

6 Total Hours Theory: 3 hours Practical: 3 hours

6.4 Steering Systems

6 Total Hours Theory: 6 hours Practical: 0 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
65%	35%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Solid Tire/ Wheel Assembly	Pneumatic Tire/Wheel Assembly
Steer Axle Assembly	Measuring Tools

S1274.1 Suspension Systems

Duration: Total 14 hours Theory 8 hours Practical 6 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5871.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to diagnose and repair suspension systems according to manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.1.1 Describe the purpose and fundamentals of suspension system assemblies.

[1/0]
- **hydraulic accumulator/shock action**
- **centre of gravity/centrifugal force/inertia**
- **coefficient of friction**
- **static and kinetic friction**
- **effects of heat on metal**

6.1.2 Identify the functions, construction features, and composition of suspension system components.

[2/0]
- **frame types**
  - unitized body
  - rubber block
- **three-point suspension**
- **active suspension**
- **articulation points**
- **solid suspension system components**
  - load carrying pillow block assemblies

6.1.3 Explain the principles of operation of powered lift truck suspension systems.

[4/0]
- **load transfer**
- **jounce and rebound**
- **suspension system types**
  - solid
  - hydraulic
- **shock absorption principles**
- **caster assemblies**

- **characteristics of suspension materials**
  - spring steel
  - synthetic rubber
- **active suspensions**
  - hydraulic
- **counter balance principles**

6.1.4 Perform inspection, testing, and failure analysis procedures following manufacturers' recommendations for suspension system assemblies.

[0/2]
- **visual inspection checking for:**
  - suspension component wear
- **suspension condition assessment and failure analysis**
- **wheel bearing pre-load and endplay diagnosis**

6.1.5 Describe manufacturers' recommended system maintenance and adjustment procedures on wheels, bearings, and suspension components.

[1/4]
- **suspension system**
  - chassis lubrication
- **replace hubs and bearings**
- **perform bearing adjustment and lubrication**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1274.2 Solid Wheels and Tires

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5881.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to describe inspection, testing procedures of solid tires and wheels following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.2.1 Describe the purpose and fundamentals of solid tires and wheels.

[1/0]
- **tire ratings**
- **tire constructions**
- **tire application**
- **wheel types and application**
- **mounting hardware and applications**

6.2.2 Identify the functions, construction features, and composition of solid tires and wheels.

[1/0]
- **steel wheels**
- **wire-tex tires**
- **rubber tires**
- **urethane tires**
- **non-marking tires**
- **perm-a-fill tires (liquid plastic filled–puncture proof)**
- **granite grip tires**
- **mounting**
- **hardware and spacers**

6.2.3 Explain the principles of operation of solid tires and wheels.

[1/0]
- **steel wheels-off set**
- **wire-tex tires**
- **rubber tires**
- **urethane tires**
- **non-marking tires**
- **perm-a-fill tires (liquid plastic filled–puncture proof)**
- **granite grip tires**
- **mounting**
- **hardware and spacers**

6.2.4 Perform or demonstrate the inspection procedures for testing solid tires and wheels.

[0/1]
- **tire wear analysis**
- **de-bonding of tire from wheel**
- **cuts and cracks**
- **rim condition**
- **wheel bolt torque**

6.2.5 Recommend reconditioning and repairs following manufacturers' recommendations for solid tires and wheels.

[0/2]
- **press on and off process**
- **friction fit to wheel**
- **moulding process of urethane to wheel**
- **mounting hardware and spacers**
- **moulding of tire to wheel**
- **replace rubber onto rim**
- **mounting hardware**
  - studs
  - spacers
  - dual wheels

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1274.3 Pneumatic Wheels and Tires

Duration: Total 6 hours Theory 3 hours Practical 3 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5880.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to diagnose and repair pneumatic tires and wheels following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.3.1 Describe the purpose and fundamentals of pneumatic tires and wheels.

[0.5/0]
- **tire ratings**
- **tire construction**
- **tire application**
- **wheels construction and application**
- **mounting hardware and spacers**

6.3.2 Identify the functions, construction features, and composition of pneumatic tires and wheels.

[1.5/0]
- **full-pneumatic tires**
- **semi-pneumatic tires**
- **one-piece wheel**
- **two-piece wheel**
- **mounting hardware and spacers**

6.3.3 Explain the principles of operation of pneumatic tires and wheels.

[1/0]
- **full-pneumatic tires**
- **semi-pneumatic tires**
- **one-piece wheel**
- **two-piece wheel**
  - split rim
- **mounting hardware and spacers**

6.3.4 Perform inspection and testing procedures following manufacturers' recommendations for pneumatic tires and wheels.

[0/2]
- **tire wear**
- **side-wall damage**
- **cracking and cuts**
- **valve stem**
- **rim condition**
- **wheel bolt torque**
- **mounting hardware and spacers**
- **semi-pneumatic tires**
- **one-piece wheel**
- **two-piece wheel**
  - split rim

6.3.5 Recommend reconditioning or repairs following manufacturers' recommendations for installation and removal procedures of pneumatic tires and wheels.

[0/1]
- **breakdown and reassembly**
- **semi-pneumatic tires and wheels**
- **mounting hardware and spacer configuration**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection
  - control of hazardous materials
  - ventilation of work areas
  - lifting/hoisting procedures
  - high-pressure fluid injection/penetration to skin
  - supporting, blocking hydraulic components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1274.4 Steering Systems

Duration: Total 6 hours Theory 6 hours Practical 0 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5868

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to inspect and repair steering systems following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.4.1 Describe the purpose and fundamentals of manual steering systems.

[1/0]
- **Ackermann–angle principle**
- **parallelogram**
- **steering geometry terms and definitions**
- **caster angles**
- **camber angles**
- **toe adjustments**
- **elliot and reverse-elliot axle ends**

6.4.2 Identify the functions, construction features, and composition of steering systems.

[2/0]
- **steering linkages**
- **idler arm**
- **link rods**
- **tie rod ends**
- **steering system components**
  - HMU (Hand Metering Unit)
  - priority valves
  - steering cylinder

6.4.3 Explain the principles of operation of steering systems.

[3/0]
- **steering linkages and geometry**
- **idler arm**
- **control arms**
- **link rods**
- **tie rod ends**
- **steering system components**
  - HMU (Hand Metering Unit)
  - priority valves
  - steering cylinder

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - eye, hearing, hand ands skin protection
  - control of hazardous materials
  - lifting/hoisting procedures
  - supporting, blocking hydraulic components
  - dismantling use of brass drifts
  - control of snap ring and locking ring removal
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1275**

Reportable Subject: **FRAME, DRIVE, AND LIFT SYSTEMS**

Duration: Total 48 hours Theory 31 hours Practical 17hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

7.1 Final Drive Units

14 Total Hours Theory: 9 hours Practical: 5 hours

7.2 Cab Systems, Frames, and Protection Devices

10 Total Hours Theory: 6 hours Practical: 4 hours

7.3 Chain Systems

12 Total Hours Theory: 8 hours Practical: 4 hours

7.4 Power shift Transmissions and Torque Converters

12 Total Hours Theory: 8 hours Practical: 4 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
65%	35%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
OEM Service Manuals

Recommended Minimum Equipment:

Power shift Transmissions	Torque Converters
IC and EV Lift Trucks	Measuring Tools

S1275.1 Final Drive Units

Duration: Total 14 hours Theory 9 hours Practical 5 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5867, 5874

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend repair procedures for powered lift truck final drive carriers following manufacturers' recommendations and safe working practices.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.1.1 Describe the purposes and fundamentals of final drive carriers.

[2/0]
- **centrifugal force**
- **linear movement**
- **angular movement**
- **lubricating oils, including temperature and load requirements**
- **planetary gear sets**

7.1.2 Identify the construction features of final drive carriers.

[1/0]
- **inboard and outboard**
- **planetary**
- **carrier/housing**

7.1.3 Explain the principles of operation of powered lift truck final drive carriers.

[6/0]
- **final drives**
  - inboard and outboard
  - planetary
- **torque multiplication**
- **power flow**
- **ratio**

7.1.4 Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations for powered lift truck final drive carriers.

[0/3]
- **inspect final drive carriers and check for:**
  - bearing pre-load
- **diagnose and analyze component failures for:**
  - noises
  - wear
  - breakage
  - overheating
  - lack of proper lubrication

7.1.5 Recommend maintenance procedures following manufacturers' recommendations for powered lift truck final drive carriers.

[0/2]
- **demonstrate the dismantling and assembling procedures:**
  - outline seal replacement procedure
  - outline bearing service procedure
- **maintenance procedures for:**
  - check lubricating oil levels
  - verify condition of gear oil
  - review procedure for changing the gear oil
  - identify recommended gear oil classifications

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1275.2 Cab Systems, Frames, and Protection Devices

Duration: Total 10 hours Theory 6 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5879.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to describe the diagnostic and repair procedures for cab systems, frames, and protection devices.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.2.1 Describe the purposes and fundamentals of cab systems, components, frames, and protection devices.

[1/0]
- **counter weighting**
  - geometric calculations
  - battery counter weighing
  - frame counter weighing
- **falling object protection system (FOPS) Over Head Guard (O.H.G.)**
- **operator restraint systems**
- **noise control**
- **operators' compartment shielding**
- **regulatory requirements**
- **fire extinguishers**

7.2.2 Identify the basic functions, construction features, and composition of cab systems, components, frames, and protection devices.

[2/0]
- **counter weighting**
  - positions
  - battery counter weighing
  - frame counter weighing
- **falling object protection system (FOPS) Over Head Guard (O.H.G.)**
- **noise control**
- **operator protection systems (OPS)**
- **operators' compartment shielding**
- **fire extinguishers**
- **operator restraint systems**

7.2.3 Explain the principles of operation of cab systems, components, frames, and protection devices.

[3/0]
- **counter weighting**
  - positions
  - battery counter weighting
  - frame counter weighting
- **falling object protection system (FOPS) Over Head Guard (O.H.G.)**
- **noise control**
- **operator protection systems (OPS)**
- **operators' compartment shielding**
- **fire extinguishers**
- **operator restraint systems**

7.2.4 Perform inspection and diagnostic procedures for cab systems, components, frames, and protection devices following manufacturers' recommendations and government regulations.

[0/2]
- **demonstrate procedures for:**
  - counter weighting
  - frame counter weighting
  - fastener torque
  - alterations
  - additions
  - falling object protection system (FOPS) Over Head Guard (O.H.G.)
  - fastener torque
  - alterations
  - additions
- **noise control**
- **operator protection systems (OPS)**
  - fastener torque
  - interlock systems
  - alterations
  - additions
- **operators' compartment shielding**
- **fire extinguishers**
- **operator restraint systems**
- **demonstrate the diagnostic procedures checking for:**
  - wear
  - distortion
  - fractures
  - corrosion
  - defective components

7.2.5 Recommend reconditioning or repairs following manufacturers' recommendations and government regulations to cab systems, components, frames, and protection devices.

[0/2]
- **demonstrate counter-weighting**
  - frame counter-weighting
  - fastener torque
- **demonstrate the replacement procedures for:**
  - fastener torque
  - falling object protection system (FOPS**)**
  - fastener torque
  - noise control
  - operator protection systems (OPS)
  - fastener torque
  - interlock systems
  - operators' compartment shielding
  - fire extinguishers
  - operator restraint systems

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1275.3 Chain Systems

Duration: Total 12 hours Theory 8 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5876.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to diagnose and repair chain systems following manufacturers' specifications.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.3.1 Describe the purpose and fundamentals of chain systems.

[1/0]
- **sheaves**
  - bushings
  - roller bearings
  - shafts
  - pre-tension mechanisms
- **chain systems**
  - applications
  - friction
  - ratios

7.3.2 Identify the functions, construction features, and composition of chain systems.

[2/0]
- **chains**
- **sheaves**
  - bushings
  - roller bearings
  - shafts
  - tensioners

7.3.3 Explain the principles of operation of chain systems.

[4/0]
- **size, speed, and power relationships**
- **arc and content**
- **alignment**
- **lubrication**

7.3.4 Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations on chain systems.

[0.5/2]
- **system inspection procedures checking for:**
  - cracks
  - wear
  - deterioration
  - alignment
  - lubrication
- **chain tests**
- **diagnostic procedures of chain systems**

7.3.5 Recommend reconditioning or repairs following manufacturers' recommendations for chain systems.

[0.5/2]
- **removal and replacement procedures of:**
  - chains
  - sheaves
    - bushings
    - roller bearings
    - shafts
    - tensioners
- **tension adjustments of:**
  - chains

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1275.4 Power Shift Transmissions and Torque Converters

Duration: Total 12 hours Theory 8 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5866.08, 5866.09, 5866.10, 5866.11, 5866.12, 5866.13

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend repair procedures for powered lift truck Power Shift Transmissions and Torque Converters following manufacturers' recommendations and safe working practices.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.4.1 Describe the purposes and fundamentals of power shift transmissions and torque converters.

[2/0]
- **fundamentals**
  - fluid dynamics within torque converter
    - vortex flow
    - rotary flow
  - fluid coupling
  - torque converter
  - power shift transmission fluid schematics
  - power shift transmission gear configuration’s
    - forward-reverse shuttle
    - multiple speed transmissions

7.4.2 Identify the construction features of power shift transmissions and torque converters.

[2/0]
- **torque converters**
  - impeller
  - stator / multi stage / variable pitch
  - turbine
  - non serviceable and serviceable torque converters
- **power shift transmissions**
  - pumps / internal and external gear
  - clutch Pack assemblies
  - fluid containment / seals and sealing rings
  - valve bodies and modulation valves
  - transmission case

7.4.3 Explain the principles of operation of powered lift truck power shift transmissions and torque converters.

[4/0]
- **torque converters**
  - torque converter fluid principles
    - vortex Flow
    - rotary Flow
  - impeller
  - stator / multi stage / variable pitch
  - turbine
  - torque multiplication and stall speed
- **power shift transmissions**
  - pumps / internal and external
  - clutch Pack assemblies
  - fluid containment / seals and sealing rings
  - gear configurations and ratios
  - power flow
- **transmission electrical systems**
  - interlocks for shift control
  - dynamic braking
  - safety interlocks
  - transmission ECM interface with engine management systems

7.4.4 Demonstrate inspection, testing, and diagnostic procedures following manufacturers' recommendations for powered lift truck power shift transmissions and torque converters.

[0/2]
- **power shift transmissions and torque converters for:**
  - transmission oil coolers
    - fluid type
    - air type
  - engine cooling system pressure checks
    - cross contamination
  - transmission external fluid lines
  - torque converter stall speed
  - pressure checks
  - fluid analysis
  - shifting sequence and engagement
    - electrical
    - mechanical
  - inching systems
    - electric
    - mechanical
    - hydraulic
  - transmission case and bearings
  - transmission electrical systems
    - interlocks for shift control
    - dynamic braking
    - safety interlocks

- **diagnose and analyze component failures for:**
  - noises
  - wear
  - breakage
  - shift problems / slippage
  - overheating
  - fluid leaks / internal and external
  - oil coolers and Cross contamination
- **transmission electrical systems**
  - interlocks for dynamic braking
  - safety interlocks
    - shift control
    - vehicle Start

7.4.5 Recommend maintenance procedures following manufacturers' recommendations for powered lift truck power shift transmissions and torque converters.

[0/2]
- **demonstrate the dismantling and assembling procedures:**
  - non serviceable and serviceable torque converters
  - seal installation
  - bearing installation
  - torque converter run out
  - transmission case and bearings
  - internal and external gear pumps
  - clutch pack assemblies
  - oil coolers and cross contamination
- **component measurements**
  - torque converter drive
  - serviceable torque converter/stall adjustments
  - clutch pack assemblies
    - plate and disc measurements
  - input and output shafts
  - counter shaft
  - gear train
    - preload
    - backlash
  - transmission ECM interface with engine management systems
- **maintenance procedures for:**
  - check lubricating oil levels
  - verify condition of transmission oil / oil analysis
  - review procedure for changing the transmission oil filters and screens
    - identify recommended transmission oil classifications
    - cooling systems

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: **S1276**

Reportable Subject: **HYDRAULIC SYSTEMS**

Duration: Total 40 hours Theory 27 hours Practical 13 hours

Prerequisites: C.V.A.E. Level 1

Co-requisites: None

8.1 Graphic Symbols and Calculations

4 Total Hours Theory: 4 hours Practical: 0 hours

8.2 Fluid and Conditioners

4 Total Hours Theory: 3 hours Practical: 1 hour

8.3 Fluid Conductors and Fittings

6 Total Hours Theory: 4 hours Practical: 2 hours

8.4 Hydraulic Control Systems

14 Total Hours Theory: 8 hours Practical: 6 hours

8.5 Hydraulic Pumps

12 Total Hours Theory: 8 hours Practical: 4 hours

Evaluation Structure: Assignments related to theory and appropriate application skills.
Proctored final exam.
Periodic quizzes.

Mark Distribution:

Theory Testing	Practical Application Testing
65%	35%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Assortment of Hydraulic Components	Measuring Tools

S1276.1 Graphic Symbols and Calculations

Duration: Total 4 hours Theory 4 hours Practical 0 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5876.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to interpret schematics and perform pressure, force, and area calculations related to hydraulics.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

8.1.1 Describe the purpose and fundamental information of hydraulic circuits and schematics.

[1/0]
- **graphic symbols**
- **hydraulic circuit layouts**
- **pictorial drawings**
- **diagrams**
- **schematics**
- **Society of Automotive Engineers (SAE)**
- **International Standards Organization (ISO)**

8.1.2 Identify hydraulic component diagrams and schematics.

[1/0]
- **pumps**
- **valves**
- **actuators**
- **conductors**

8.1.3 Explain draft a sample of a hydraulic system schematic.

[1/0]
- **open centre circuit**
- **closed centre circuit**

8.1.4 Perform basic mathematical calculations for hydraulic applications.

[1/0]
- **pressure**
- **force**
- **area**
  - imperial
  - système international d'unités (s.i.)

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1276.2 Fluids and Conditioners

Duration: Total 4 hours Theory 3 hours Practical 1 hour

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5876.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to describe the service procedures of hydraulic reservoirs and conditioners following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

8.2.1 Describe the purpose and fundamental information of hydraulic fluids.

[0.5/0]
- **fluid type**
  - petroleum base
  - fire resistant
  - synthetic
- **viscosity/index**
- **friction**
- **cavitation**
- **velocity**
  - laminar flow
  - turbulent flow
- **pressure and force**
- **flow rate**
- **aeration**
- **wear prevention**
- **oxidation inhibitors**
- **rust and corrosion inhibitors**
- **anti-foaming**
- **water control**
- **energy transmission**
  - Pascal's Law
  - potential, heat, and kinetic
- **displacement**
- **thermal expansion**
- **contamination**
  - oil analysis
- **head pressure of fluid**

8.2.2 Identify the purpose and fundamentals of oil conditioners.

[1/0]
- **filter requirements**
- **cleanliness requirements**
- **schematics/symbols**
- **filters**
  - flow capacity
  - element rating
    - micron rating
    - beta ratio
  - type and location
  - pressure drop
  - indicators
- **coolers**
  - flow capacity
  - oil to air
  - oil to oil
  - oil to coolant
  - pressure drop
  - indicators
- **reservoirs**
  - vented
  - pressurized
  - physical features

8.2.3 Explain the construction features of oil conditioners.

[0.5/0]
- **filters and strainers**
  - surface media elements
  - depth media elements
  - micron rating
  - type and location
  - pressure drop
  - restriction indicators
- **oil coolers**
  - air to oil
  - coolant to oil
  - oil to oil
    - tube
    - tube and fin
    - radiator
- **oil heaters**
- **reservoirs**
  - capacity
  - baffles
  - outlet and return
  - drain plugs
  - intake filter
  - venting
  - pressurized

8.2.4 Explain the principles of operation of hydraulic oil conditioners.

[1/0]
- **filters and strainers**
  - surface media elements
  - depth media elements
  - micron rating
  - beta ratio
  - type and location
  - pressure drop
  - restriction indicators
- **oil coolers**
  - air to oil
  - coolant to oil
  - oil to oil
    - tube
    - tube and fin
    - radiator
- **oil heaters**
- **reservoirs**
  - pressurized
  - cooling
  - aeration
  - venting

8.2.5 Perform the inspection and testing procedures following manufacturers' recommendations of oil conditioners.

[0/1]
- **demonstrate the inspection and testing procedures of:**
  - oil filters
  - strainers
  - coolers
  - heaters
- **demonstrate the removal and replacement of filters and strainers**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
  - eye and hand protection
  - high pressure concerns for skin penetration
  - chemical hazards-WHMIS
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1276.3 Fluid Conductors and Fittings

Duration: Total 6 hours Theory 4 hours Practical 2 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5876.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to replace hydraulic lines and fittings following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

8.3.1 Describe the purpose and fundamental information of hydraulic fluid conductors.

[1/0]
- **pipes**
- **tubes**
- **hoses**
- **fittings**
- **adapters**
- **Society of Automotive Engineers (SAE)**
- **système international d'unités (s.i.)**

8.3.2 Identify the types and construction features of hydraulic fittings and conductors.

[1/0]
- **pipe**
  - schedules
  - threading
  - sizing
- **tubing**
  - plastic
  - steel
  - sizing
  - bending
  - fabricating
- **hoses**
  - sizing
  - pressure rating
    - braiding types
    - spiral wraps
- **fittings**
  - permanent
  - reusable
  - hose assembly

- **adapters**
  - thread forms
  - sealing element
- **fittings identification**
  - Society of Automotive Engineers (SAE)
  - Joint Industry Conference (JIC)
  - O-Ring Face Seal (ORFS)
  - O-Ring Boss (ORB)
  - National Pipe (NP)
  - British Standard Pipe/Japanese Industrial Standard (BSP/JIS)
  - metric
  - système international d'unités (s.i.)

8.3.3 Explain the principles of operation of hydraulic conductors and fittings.

[2/0]
- **sealing methods**
- **minimum bend radius**
- **operating pressure ratings**
- **burst pressure ratings**

8.3.4 Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations for hydraulic conductors.

[0/1]
- **inspection and testing of hydraulic conductors**
  - cracks
  - leaks
- **diagnostic procedures for hydraulic conductor failures**
  - fractures
  - restrictions

8.3.5 Recommend reconditioning or repairs following manufacturers' recommendations for hydraulic conductors.

[0/1]
- **perform a demonstration of repairing and replacing hydraulic conductors**
  - hose replacement

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
  - eye and hand protection
  - high pressure concerns for skin penetration
  - chemical hazards-WHMIS
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1276.4 Hydraulic Control Systems

Duration: Total 14 hours Theory 8 hours Practical 6 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5876.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend repairs of hydraulic control valves following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

8.4.1 Describe the purposes and fundamentals of hydraulic control valves.

[2/0]
- **pressure control valves**
- **flow control valves**
- **directional control valves**
- **fundamentals enhancement**
  - contamination and importance of cleanliness

8.4.2 Identify the types and construction features of hydraulic control valves.

[2/0]
- **pressure control valves**
  - direct acting relief
  - pilot-operated relief
  - pressure reducing
  - unloading
  - sequence
  - counter balance
  - brake valve
- **flow control valves**
  - flow dividers
  - priority
  - proportional
  - pilot-operated
  - pressure compensated
  - restrictors
  - check valves

- **directional control valves**
  - mono-block
  - sectional
  - parallel passage
  - activation
    - manual
    - solenoid
      - latching
      - non latching
  - proportioning solenoid
  - pilot
  - pneumatic
  - spool
  - poppet
  - cartridge
  - rotary

8.4.3 Explain the principles of operation of hydraulic control valves.

[4/0]
- **pressure control valves**
  - simple relief
  - pilot-operating relief
  - pressure reducing
  - unloading
  - sequence
  - counterbalance
  - brake valve
- **flow control valves**
  - flow dividers
  - priority
  - proportional
  - pilot-operated
  - pressure compensated
    - flow restriction devices
  - check valves
- **directional control valves**
  - oil flow circuit
    - parallel passage
    - series parallel connection
  - centre types
    - open
    - closed
  - poppet
  - cartridge
  - rotary
- **mono-block**
- **sectional**
- **parallel passage**

8.4.4 Perform inspection and diagnostic procedures following manufacturers' recommendations of hydraulic control valves.

[0/3]
- **identify components and their locations on hydraulic systems**
- **inspect and examine control valves**
- **relate defects to primary causes of failure**

8.4.5 Recommend reconditioning or repairs following manufacturers' recommendations of hydraulic control valves.

[0/13]
- **disassemble and reassemble hydraulic control valves**
- **recommend reconditioning or repairs of hydraulic control valves**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
  - eye and hand protection
  - high pressure concerns for skin penetration
  - chemical hazards-WHMIS
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1276.5 Hydraulic Pumps

Duration: Total 12 hours Theory 8 hours Practical 4 hours

Prerequisites: C.V.A.E. Level 1

Cross-Reference to Training Standard:

PLTT 5876.0

GENERAL LEARNING OUTCOME

Upon successful completion the apprentice is able to recommend repairs of a hydraulic pump following manufacturers' recommendations.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

8.5.1 Describe the purposes and fundamentals of hydraulic pumps.

[1/0]
- **suction parameters**
- **internal oil flow**
- **pressure management**
  - seals
- **bearing load**
- **wear points**
- **fundamentals enhancement**
  - energy
  - displacement calculations
  - contamination and importance of cleanliness
  - power calculations
    - o imperial
    - o système international d'unités (s.i.)

8.5.2 Identify the types and construction features of hydraulic pumps.

[2/0]
- **positive and non-positive displacement pumps**
- **gear pumps**
  - external
  - internal
- **piston**
  - radial
  - axial
  - fixed displacement
  - variable displacement
  - pressure compensated
  - flow compensated

- **vane pumps**
  - balanced
  - unbalanced
  - fixed displacement
  - variable displacement
  - pressure compensated
  - flow compensated

8.5.3 Explain the principles of operation of hydraulic pumps.

[5/0]
- **gear pumps**
  - external
  - internal
- **piston**
  - radial
  - axial
  - fixed displacement
  - variable displacement
  - pressure compensated
  - flow compensated
  - torque limiting compensators
  - electronically controlled compensators
- **vane pumps**
  - balanced
  - unbalanced
  - fixed displacement
  - variable displacement
  - pressure compensated
  - flow compensated

8.5.4 Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations for hydraulic pumps.

[0/2]
- **describe pump internal and external leak tests**
- **dismantle, inspect, and assemble gear, vane, and piston pumps**
- **diagnose pump failures and analyze damaged components**

8.5.5 Recommend reconditioning or repairs following manufacturers' recommendations of hydraulic pumps.

[0/2]
- **outline the recommended disassembly and reassembly procedures**
- **demonstrate the disassembly and reconditioning procedures for a hydraulic pump assembly**

GENERAL PRACTICES

This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the Learning Content.

- **safety precautions**
  - pressure escape and containment
  - eye, hearing and skin protection from hot fluids
  - hazardous materials
  - lifting and hoisting
  - ventilation of work area
  - fire hazard
  - high pressure fluid injection/skin penetration
  - supporting and blocking of components
  - eye and hand protection
  - high pressure concerns for skin penetration
  - chemical hazards-WHMIS
- **communications**
  - information accessing
  - practical reporting
  - technical service bulletins
  - data management systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Acronyms:

This listing identifies acronyms found in the following motive power curriculum documents:

Level 1 – Commercial Vehicles and Equipment (Common Core)
Level 2 – Commercial Vehicles and Equipment (Common Core)
Level 3 – Agricultural Equipment Technician
Level 3 – Heavy Duty Equipment Technician
Level 2 – Powered Lift Truck Technician
Level 3 – Powered Lift Truck Technician
Level 2 – Truck and Coach Technician
Level 3 – Truck and Coach Technician

A

ABS	anti-lock braking system
AC	alternating current
A/C	air conditioning
AET	Agricultural Equipment Technician
AFC	air fuel control
AGM	absorbed glass mat
API	American Petroleum Institute
ANSI	American National Standards Institute
ATA	American Trucking Association
ATC	automatic traction control
AVR	amp, volt, ohmmeter
AWG	American Wire Gauge
AWS	American Welding Society

B

BCM	body control module
BSP	British Standard Pipe
BTM	brushless torque motor

C

CB	citizen band
CDI	capacitor discharge ignition
CD-ROM	compact disc read only memory
CFC	chlorofluorocarbons
CI	compression ignited
CMVSS	Canadian Motor Vehicle Safety Standard
CNG	compressed natural gas
CPU	central processing unit
CSA	Canadian Standards Association
CVSA	Canadian Vehicle Standards Association
CWS	collision warning systems

D

DC	direct current
DDC	Detroit Diesel Corporation
DFF	direct fuel feed
DIN	Deutsche Institute fur Normung (German Standards Institute)
DMM	digital multimeter

DOS	Disk Operating System
DOT	Department of Transportation
DPF	diesel particulate filter

E

ECM	electronic control module
ECU	electronic control unit
EPROM	erasable programmable read only memory
EEPROM	electronically erasable programmable read only memory
EG	ethylene glycol
EGR	exhaust gas recirculation
ELC	extended life coolant
EPA	Environmental Protection Act
EST	electronic service tool
EUI	electronic unit injector
EUP	electronic unit pump

F

FHSL	Federal Health and Safety Legislation
FMIs	fault mode indicators
FMVSS	Federal Motor Vehicle Safety Standards
FOPS	Falling Object Protection System
FRP	fiberglass reinforced plywood

G

GCWR	Gross Combined Weight Rating
GFI	gasoline fuel injection
GPS	global positioning satellite
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating

H

HC	hydrocarbon
HDET	Heavy Duty Equipment Technician
HEUI	hydraulically actuated electronic unit injector
HCFC	hydrochlorofluorocarbons
HFC	hydrofluorocarbons
HPI-TP	high pressure injector-time pressure (Cummins)
HVAC	heating, ventilation and air conditioning

I

ID	inside diameter
ISO	International Standards Organization

J

JIC	Joint Industry Conference
JIS	Japanese Industrial Standard
JIT	just in time

K

KPI	king pin inclination

L

LED	light emitting diode
LPG	liquid petroleum gas
LVD	low voltage disconnect

M

MAP	manifold absolute pressure
MIDs	message identifiers
MIG	metal inert gas
MSDS	material safety data sheet
MUI	mechanical unit injector
MVSA	Motor Vehicle Safety Act (Canadian)

N

N/A	not applicable
NOP	nozzle opening pressure
NPN	negative positive negative semi-conductor
NPT	National Pipe Thread
NV-RAM	non-volatile random access memory

O

OD	outside diameter
ODP	ozone depletion prevention
OEM	original equipment manufacturer
OHSA	Occupational Health and Safety Act
OOS	out of service criteria
OPS	operator protection system
ORB	o-ring boss
ORFS	o-ring face seal

P

PC	personal computer
PCV	positive crankcase ventilation
PFI	port fuel injection
PG	propylene glycol
PHSL	Provincial Health and Safety Legislation
PIDs	parameter identifiers
PLTT	Powered Lift Truck Technician
PNP	positive negative positive semi-conductor
PROM	programmable read only memory
PT	pressure time
PTA	pressure time (injector) A series
PTG-AFC	pressure time governor/air fuel control
PTD	pressure time (injector) B series
PTG	pressure time governor (control pump)
PTO	power take-off
PWM	pulse width modulation

R

RAM	random access memory
RBM	resist bend moment
ROM	read only memory
ROPS	roll over protection system
R.P.	recommended practices
RPM	revolutions per minute

S

SAE	Society of Automotive Engineers
SALT	sealed and lubricated tracks
SCA	supplemental coolant additives
SI	spark ignited
s.i.	Système International d'Unités
SIDs	sub-system identifiers
SMAW	shielded metal arc welding
SRS	supplemental restraint systems
STC	step timing control

T

TBI	throttle body injection
TCT	Truck and Coach Technician
TDS	total dissolved solids
TP	time/pressure injector
TPS	throttle position sensor
TQM	total quality management
TMC	Technical and Maintenance Council

V

VCO	valve closes orifice
VIN	vehicle identification number

W

WHMIS	Workplace Hazardous Materials Information System
WIF	water in fuel sensors

Glossary:

This glossary provides definitions of terms found in the following motive power curriculum documents:

Level 1 – Commercial Vehicles and Equipment (Common Core)
Level 2 – Commercial Vehicles and Equipment (Common Core)
Level 3 – Agricultural Equipment Technician
Level 3 – Heavy Duty Equipment Technician
Level 2 – Powered Lift Truck Technician
Level 3 – Powered Lift Truck Technician
Level 2 – Truck and Coach Technician
Level 3 – Truck and Coach Technician

A

ABS	Anti-lock braking system. Electronically controlled brakes that monitor vehicle wheel speeds and manage application forces to prevent wheel lock-up.
AC	See *alternating current.*
A/C	Air conditioning.
accumulator	A cylinder or device used to store pressure, can contain a diaphragm and pneumatic pressure. Used in hydraulic systems.
Ackermann Angle	Angle between the planes of the steered wheels of a vehicle with zero steering angle; a measure of toe-in or toe-out.
acronym	A word formed by the initial letters of other words.
active codes	An electronically monitored system circuit, condition, or component that is malfunctioning and logs an ECM code, which may be displayed or read using an EST.
actuator	Any output device controlled by a computer. Also used in hydraulics as an output device such as a linear or rotary device (cylinder or motor).
aeration	The mixing of gas with a liquid, usually air with oil, fuel, or coolant.
AFC	Air/fuel control.
AFC (Cummins)	A circuit that senses turbo boost sensing and is part of the fuel management components on a Cummins PTC-AFC pump.
AFR	See *air/fuel ratio.*
air/fuel ratio	The mass ratio of an air-to-fuel mixture; also AFR.
air-to-air aftercooler	Heat exchanger that cools the intake air after the turbocharger before going to the intake manifold, by using ambient air.
alcohol	Any of a group of distillate hydrocarbon liquids containing at least one hydroxyl group; sometimes referred to as oxygenates.
aldehydes	A class of chemical compounds having the general formula RCHO, where R is an alkyl (aliphatic) or aryl (aromatic) radical (SAE J1213 NOV82).
alloy	The mixing of a molten base metal with metallic or non-metallic elements to alter the metallurgical characteristics.
alternating current	Electric current that reverses cyclically due to reversal of polarity at the voltage source; AC.
altitude-pressure	Any sensor or device that automatically compensates for

compensator	changes in altitude.
Amboid gear	A bevel gear crown and pinion assembly where the axes are at right angles but the pinion is on a higher plane than the crown.
ANSI	The American National Standards Institute.
American Society for Testing Materials (ASTM)	Agency that sets industry standards and regulations, including those for fuel.
ammeter	Instrument for measuring current flow.
ampere (A)	The unit of measurement for the flow of electric current. An ampere is defined as the amount of current that one volt can send through one ohm of resistance.
analog	The use of physical variables, such as voltage or length, to represent values.
anaerobic sealant	Paste-like sealants that cure (harden) without exposure to air.
aneroid	A device used to sense light pressure conditions. The term is used to describe manifold boost sensors that limit fueling until there is sufficient boost air to combust it and usually consists of a diaphragm, spring, and fuel-limiting mechanism.
antifreeze	A liquid solution added to water to blend the engine coolant solution that raises the boiling point and lowers the freezing point. Ethylene glycol (EG), propylene glycol (PG), and extended life coolants (ELC) are currently used.
antifriction bearing	A bearing that uses balls or rollers between a journal and a bearing surface to decrease friction.
API	The American Petroleum Institute.
application software	Programs that direct computer processing operations.
Apprentice program	Any educational program designed to teach a trade through a combination of on-the-job training and classroom study.
Apprentice technician	A beginner who is learning under the direction of one or more experienced certified technicians.
Aqueous Solution	A solution in water, eg. a homogeneous mixture of two or more substances; frequently (but not necessarily) a liquid solution; "he used a solution of peroxide and water"
Aqueous Urea Injection	Is a system that is designed for reducing NOx (Nitrous Oxide) emissions formed in the presence of high combustion temperatures in internal combustion diesel engines. By injecting urea in the exhaust stream, it causes the NOx to break down into nitrogen and oxygen.
arcing	Bearing or gear failure caused by electric arcing.
articulating piston	A two-piece piston with separate crown and skirt assemblies, linked by the piston wrist pin and afforded a degree of independent movement. The wrist pin is usually full floating or bolted directly to the connecting rod, in which case it is known as a *crosshead piston.*
ASTM	American Society for Testing Materials. Standards rating organization that classifies materials generally and all fuels.
ATA	American Trucking Association. Organization with a broad spectrum of representation responsible for setting standards in the U.S. trucking industry.
ATA data link	An SAE/ATA standard J1584/J1708/J1939, 6-pin Deutsche

	connector currently used by all truck and truck engine OEMs to access the on-board ECMs.
ATAAC	Air-to-air charge air cooling.
ATDC	After top dead centre.
atom	The smallest part of a chemical element that can take part in a chemical reaction; composed of electrons, protons, and neutrons.
atomization	The process of breaking liquid fuel into small droplets by pumping it at a high pressure through a minute flow area.
atomized droplets	The liquid droplets emitted from an injector nozzle.
audit trail	A means of electronically tracking electronically monitored problems in an engine management system. May be discreet, that is, not read by some diagnostic ESTs and programs; also known as *tattletale.*

B

backfire	Ignition/combustion of the fuel in an oxy-acetylene torch in the torch tip causing a popping and squealing noise.
backlash	The clearance or "play" between two parts, such as the teeth of two gears.
battery	A device containing one or more cells that produces electricity through electrochemical action.
battery capacity	The amount of current a battery is capable of delivering.
battery charging	The process of restoring a battery's charge by passing current through it in a reverse direction (positive to negative).
battery plate	Battery components made of lead peroxide in sponge form and porous lead.
battery rating	Standardized measurement of a battery's ability to deliver an acceptable level of energy under specified conditions. Standards established by the battery council international (BCI).
baud	Times per second that a data communications signal changes and permits one bit of data to be transmitted.
baud rate	The speed of a data transmission.
Bernoulli's Principle	The statement that an increase in the speed of a fluid produces a decrease in pressure and a decrease in the speed produces an increase in pressure
beta ratio	The beta ratio or rating is used for fine filters and is determined under laboratory testing. Although not a true measure of how well a filter will do in an operating system, the beta rating is a good indicator of the filter performance. The beta ratio of an operating filter during steady state flow test is simply the count upstream divided by the count downstream of fine test dust, based on any selected particle size.
binary system	A two-digit arithmetic, numeric system commonly used in computer electronics.
blower	A low-pressure air pump used on diesel engines to increase the amount and pressure of the air coming into the engine. Sometimes referred to as a *supercharger.*
boost pressure sensor	This sensor measures intake manifold air pressure and sends a signal to the ECM.
boost pressure	A measure of positive air pressure provided by a supercharger

	or turbocharger.
bore	The diameter of an engine cylinder. Sometimes used to refer to the cylinder itself.
boundary lubrication	Thin film lubrication characteristics of an oil.
Boyle's Law	The absolute pressure of a fixed mass of gas varies inversely as the volume, provided the temperature remains constant.
brake power	Power developed by an engine measured at the flywheel measured by a dynamometer or *brake*. Factored by *torque* or RPM.
British thermal unit (BTU)	Measurement of the amount of heat required to raise the temperature of one pound of water by 1 degree F, at sea level.
broach	A boring bit used for final, accurate bore sizing.
BTM	Brushless torque motor. Caterpillar rotary proportional solenoid used for PEEC timing and rack position control.
bypass filter	A filter assembly plumbed in parallel with the lubrication circuit, usually capable of high filtering efficiencies.
bypass valve	A diverter valve fitted to full flow filter (series) mounting pads, designed to reroute lubricant around a plugged filter element to prevent a major engine failure.
burst pressure	The pressure which causes rupture. Also, the inside out differential pressure that causes out-ward structural failures.

C

cache	High speed RAM located between the CPU and main memory used to increase processing efficiency.
calorific value	The heating value of a fuel measured in BTU, calories, or joules.
calibration parameters	The specific values required when setting performance to specification.
calipers	Comparative measuring instrument used for measuring outside diameter and inside diameter.
cam ground	Trunk-type pistons that are machined slightly eccentrically. Because of the greater mass of material required at the wrist pin boss, this area will expand proportionally more when heated. Cam ground pistons are designed to assume a true circular shape at operating temperatures.
capacitance	Measure of how much electrical charge can be stored for a given voltage potential; measured in farads.
capacitor	An electrical device that can store an electrical charge or block AC and pass DC. Also known as *condenser*.
carbon (C)	An element found in various forms including diamonds, charcoal, and coal. It is the primary constituent element in hydrocarbon fuels. Atomic #6.
carbon dioxide (CO_2)	One of the products of combustion. Also a dry chemical mixture that is an excellent fire retardant. Compressed into solid form this material is known as dry ice, and remains at a temperature of 109 degrees F.
carbon monoxide (CO)	A deadly colorless, odorless gas that is formed when fuel is not burned completely.
carcinogen	Any substance, such as asbestos, and carbon tetrachloride, that can cause cancer.

cardan joint	A universal joint commonly used as a driveshaft coupler permitting articulation. Two yokes are united by a rigid cross whose races run in a yoke supported needle bearings or races.
case-harden	A process of heating a piece of steel to harden its surface while the inside remains relatively soft.
catalyst	A substance that stimulates, accelerates, or enables a chemical reaction without itself undergoing any change.
catalytic converter	An exhaust system device that enables oxidation and reduction reactions; in lean burn truck diesel engines, only oxidation catalytic converters are used at this moment in time.
cavitation	Describes metal erosion caused by the formation and subsequent collapse of vapor pockets (bubbles) produced by physical pulsing into a liquid such as that of a wet liner against the wall of coolant that surrounds it. Bubble collapse causes high unit pressures and can quickly erode wet liners when the protective properties of the coolant diminish. Also known in hydraulics as a gaseous condition within a liquid stream causing the rapid implosion of a gaseous bubble.
CCW	Counter-clockwise or left hand rotation.
CD	Compact disk. Optically encoded, digital data storage.
CD-ROM	An optically encoded data disk that is read by a laser in the same way an audio CD is read and is designed for read-only data.
centrifugal filter	A filter that uses a centrifuge consisting of a rotating cylinder charged with pressurized fluid and canted jets to drive it; centrifugal filters often have high efficiencies and are often of the *bypass* type.
centrifugal force	The force acting outward on a rotating body.
centrifuge	A device that uses centrifugal propulsion or a centrifugal force principle of operation.
centripetal force	Tendency to move toward a center; such as water draining from a bathtub.
cetane	A colourless liquid ($C_{16}H_{34}$). Used as a basis to test the performance characteristics of diesel fuel.
cetane improver	A diesel fuel additive designed to increase the *cetane number* rating or ignition quality. Cyclohexanol nitrate is a commonly used cetane improver.
cetane number (CN)	The standard rating of a diesel fuel's ignition quality. It is a comparative rating method that measures the ignition quality of a diesel fuel verses that of a mixture of cretonne (good ignition characteristics). A mixture of 45% cretonne and 55% would have a CN of 45. Diesel fuels refined for use in North America are classified by the ASTM as #1D and #2D and must have a minimum CN of 40.
CFM	Cubic Feet per Minute. Used as a measurement for the amount of air entering an engine’s intake.
Charles' s Law	See Gay-Lussac's Law.
CI	Compression ignition; an engine in which the fuel/air mixture is ignited by the heat of compression.
clearance	A given space between two parts such as a piston and cylinder.

clearance volume	Volume in an engine cylinder when the piston is at TDC.
clockwise rotation	Rotation is the same as the direction as the movement of the hands of a clock.
coefficient of friction	A rating of a material's ability to generate friction. Describes the "aggressiveness" of materials in contact with each other. Affected by temperature and the presence of lubricants.
Cold crank rating (CCR)	Standard battery rating system that identifies the maximum current drain a fully charged battery can deliver at 0 degrees F or -17 degrees C - measured in cold cranking amps (CCA).
Combustion	The act of burning, *oxidation.*
Combustion chamber	In most current S.I. and C.I. engines, the engine cylinder and the geometry of the head and piston crown form the combustion chamber. In I.D.I. diesel engines, the combustion chamber is a separate cell connected to, but not integral with, the cylinder. Also, the area above the piston with the piston at TDC. Measured in cubic centimeters.
Combustion cycle	The thermodynamic process of a heat engine cycle through induction, compression, oxidation, and exhaust.
Compound	(i) A substance consisting of two or more elements held together by chemical force and not necessarily retaining any of the characteristics of the composite elements; i.e., Water: H_2O: (ii) Auxiliary gearbox that "compounds" the main transmission by increasing the available ratios and ranges.
Compression	The process by which a confined fluid is reduced in volume and increased in density with the application of pressure.
Compression ratio	The ratio of the piston swept volume to the total cylinder volume with the piston at BDC - a volumetric ratio and not a pressure ratio.
Communication Protocol	SAE has specific protocols for mobile equipment communication, such as J1939 J1587/1708
Concentric	Circles having a common centre.
Conductance	The ability of a material to carry an electrical current.
Conductors	Materials that readily permit the flow of electrons from atom to atom; usually metallic elements that have less than 4 electrons in their outer shells.
Conduction	Heat transmission through solid matter, also the transfer of heat from one object to another by being in direct contact.
Connecting rod	The rigid mechanical link between the piston wrist pin and the crankshaft throw.
Constant horsepower	Sometimes used to describe a high *torque rise* engine.
Co-requisite	A unit of learning that can be taken concurrently with another subject, but in order to be successful, both subjects must be completed successfully.
Conventional theory	(Of current flow) asserts that current flows from a positive source to a negative source. Despite the fact that it is fundamentally incorrect, it is nevertheless widely accepted and used.
Convection	A transfer of heat from one object to another through a liquid. Also heat transfer occasioned by the upward flow of hot air and the downward flow of cool air.

Counterbore	Cylindrical enlargement of the cylinder bore at the block deck to seat a liner flange.
Crankshaft	A shaft with offset throws designed to convert the reciprocating movements of the pistons into torque.
Crank throw	The offset part of the crankshaft where the connecting rods fasten.
Creep	Describes the independent movement of two components clamped by fasteners when they have different coefficients of thermal expansion or have different mass, which means their expansion and contraction rates do not concur.
Cross flow	Describes a four-stroke cycle engine breathing configuration where intake and exhaust manifolds are located on opposite sides of the cylinder head so gas flow is across the piston crown.
Crosshead	Part of the valve train in an engine that actuates two valves per cylinder. Permits two valves in the same cylinder to be opened simultaneously by a single rocker arm.
Crosshead piston	An articulating piston with separate crown and skirt assemblies in which the connecting rod is bolted directly to the wrist pin.
Crude oil	The organic fossil fuel pumped from the ground from which diesel fuel, gasoline, and many other petroleum products are refined; raw petroleum.
Current	The flow of free electrons through a conductor.
Curriculum hour	Is described as the breakdown of time for theory and practical in-school delivery. It is timed at 50 minutes per curriculum hour listed in the document.
Cycle time	A reoccurring period in which a series of actions take place in a definite order. Also used in hydraulics as the time it takes for an actuator or function to complete full extend to full retract: thus a cycle time.
Cylinder block	The main frame of any engine to which all the other components are attached.
Cylinder head	A detachable portion of an engine that covers the upper end of the cylinder bores and forms part of the combustion chamber. Also includes the valves in the case of overhead valve engines.
Cylinder sleeve	A liner or sleeve interposed between the piston and the cylinder wall or water jacket to provide an easily replaceable surface for the cylinders.

D

Damper	A unit or device used to reduce or eliminate vibration, oscillation, of a moving part, fluid, etc.
Data	Raw (unprocessed) information.
Database	A data storage location or program.
Data link	The connection point or path for data transmission in networked devices.
Data link connector	Plastic plug-in terminal with two or more electrical connections used to interface with engine or vehicle's computers.
DC	Direct current.

DCA	Diesel coolant additives. A proprietary supplemental coolant additive.
DI	Direct injection. Fuel is injected directly into the engine cylinder. This is the common means of injecting, current C.I. engines and used in some gasoline-fueled engines.
Dial indicator	Tool used to precisely measure linear travel.
Diesel cycle	A four-stroke cycle similar to the Otto cycle (intake, compression, expansion, and exhaust strokes) but where ignition of the fuel charge is occasioned by the heat of compression. A true diesel cycle engine is known as a *constant pressure* engine, meaning that fuel is metered into the cylinder at a rate that will produce constant pressure for a number of crank angle degrees.
Digital signal	An electronic signal that uses on and off pulses.
Diode	A semiconductor device that allows current flow in one direction but resists it in the other, which acts like an electrical check valve.
Displacement	The total volume displaced by the cylinders when moving from BDC to TDC.
Direct current (DC)	Electric current that flows steadily in one direction only.
Droop	An engine governor term denoting a transient speed variation that occurs when engine loading suddenly changes.
Droop curve	A required hydro-mechanical governor characteristic in which fueling drops off in an even curve as engine speed increases from the rated power value to high idle.
Dry air filter	A filter element that requires no oil or other liquid medium to trap dirt particles. Most motive power air filters are of the dry type.
Dry liners	Liners that are fitted either with fractional looseness or fractional interference that dissipate cylinder heat to the cylinder block bore and have no direct contact with the water jacket.

E

Electromagnetism	Describes any magnetic field created by current flow through a conductor.
Electron	A negatively charged component of an atom.
Electrolyte	A solution capable of conducting electrical current.
Electron theory	The theory that asserts that current flow through a circuit is by electron movement from a negatively charged point to a positively charged one. See *conventional theory*.
Electronic engine management	Computerized engine control.
Electronic control unit (ECU)	Refers to the computer and integral switching apparatus in an electronically controlled system. Some engine OEMs use this term rather than the more commonly used ECM.
Electronically controlled unit injector	Mechanically actuated, electronically controlled unit injector that combines pumping, electronic fuel metering, and injecting elements in a single unit.
Emissions	Any release of harmful materials into the environment. Gases produced from exhaust, crankcase, and fuel tanks and their contribution to smog.

End play	Amount of lengthwise movement between two parts due to clearance.
Energy	Any capacity for doing work.
Ethylene glycol	A liquid chemical used in engine coolant. See *antifreeze.*
Exhaust scrubber	An exhaust emission device used to clean particulate matter from engine exhaust. Used predominately in off road equipment for use in underground mining and enclosed buildings.
Expansion ratio	Ratio of cylinder volume at the moment the exhaust port or valves open to clearance volume; usually less than compression ratio.

F

Fatigue	Material failure or deterioration due to repetitive stress loading or usage.
Ferrous material	Metal containing metal or steel.
Fiber optics	The transmission of laser light waves through thin stands of fiber. Used to digitally pulse data more cheaply and at much higher speeds than copper wire.
Fire point	The temperature at which a flammable material or liquid vaporizes at a rate sufficient to burn continuously.
Flammable	Any substance that can be combusted.
Flashback	A highly dangerous condition that can occur in operating oxy-acetylene equipment in which the flame may travel behind the mixing chamber in the torch and explode the acetylene tank using the system oxygen. Most current oxy-acetylene torches are equipped with flashback arresters.
Fluid power	The term used to describe both *hydraulics* and *pneumatics.*
Flywheel	A large heavy wheel that forms the base for the starter ring gear and in which energy is absorbed and stored by means of momentum. Also provides a mounting surface for the torque converter or clutch assembly.
Force	The action of one body attempting to change the state of motion of another. The application of force does not necessarily result in any work accomplished.
Friction	The resistance an object or fluid encounters in moving over or though another.
Four-stroke cycle engine	An engine design where a power pulse occurs every other revolution of the crankshaft. These strokes are (1) intake stroke (2) compression (3) power or expansion stroke; and (4) exhaust stroke.
Full-floating	Used to describe components that permit more than the usual amount of movement-for instance a *full-floating piston pin* is retained in the pin boss, but permits independent movement of both the piston and the rod eye.
Full floating axle	A drive axle design where the axle shafts provide wheel torque only and bear no part of the vehicle load.

G

Gay-Lussac's Law	The law that at constant pressure the volume of a fixed mass or quantity of gas varies directly with the absolute temperature; a close approximation. Also known as Charles's

	Law.
General Learning Outcomes	Learning outcomes represent culminating demonstrations of learning and achievement. Outcomes are not simply a listing of discrete skills, nor broad statements of knowledge and comprehension. Outcomes describe performances that demonstrate that significant learning has been achieved and applied.
General Practices	This section captures concepts and topics that must be integrated into the learning for each unit. No specific time is allocated for these items as it is deemed to be accounted for in the learning content.
Governor	A component that manages engine fueling on the basis of fuel demand (accelerator) and engine RPM; may be hydro-mechanical or electronic.
Grade markings	Lines placed on the heads of some bolts to indicate tensile strength.
Gross Horsepower	The brake horsepower of an engine with optimum settings and without allowing for power absorbed by the engine-driven accessories.
Gross Torque	The maximum torque produced when measured at the engine's crankshaft. Does not allow for torque consumed by the engine-driven accessories.

H

Hall Effect	A method of accurately sensing rotational speed and digitally signaling it. A rotating metallic shutter alternately blocks and opens a magnetic field from a semiconductor sensor.
Hazardous Waste	Any chemical or material that has one or more characteristics that make it hazardous to health, life, and/or the environment.
Heat	A form of energy associated with the motion of atoms or molecules and capable of being transmitted by conduction, convection, and radiation.
Helix	A spiral groove or scroll. The helical cut recesses in some injection pumping plungers that are used to meter fuel delivery. Plural: *helices.*
Hg manometer	A mercury (Hg) filled manometer.
High Idle Speed	The highest no load speed of an engine.
Hooke's Law	The law that the stress of a solid is directly proportional to the strain applied to it.
Horsepower (hp)	Measurement of an engine's ability to perform work. One horsepower is defined as the ability to move 33,000 pounds one foot in one minute.
H_2O Manometer	A water-filled manometer.
Hunting	Rhythmic fluctuation of engine RPM usually caused by unbalanced cylinder fueling.
Hydraulics	The science and practice of confining and pressurizing liquids in circuits to provide motive power.
Hydrodynamic suspension	The principle used to float a rotating shaft on a bed of constantly changing, pressurized lubricant.
Hydraulic electronic unit injector (HEUI)	Unit injector featuring a hydraulically-actuated injection pumping, with an electronically controlled injector. Combines fuel metering and injecting elements into a single unit.

Hydrocarbon	Describes substances primarily composed of elemental carbon and hydrogen. Fossil fuels and alcohols are both hydrocarbon fuels.
Hydrodynamic engine management	All engines managed without computers.
Hydrometer	An instrument designed to measure the specific gravity of liquids, usually battery electrolyte and coolant mixtures. Not recommended for measuring either in truck engine applications where a refractometer is the appropriate instrument due to greater accuracy.
Hypoid gear	A bevel gear crown and pinion assembly where the axes are at right angles but the pinion is on a lower plane than the crown.
Hysteresis	(i) In hydro-mechanical governor terminology, a response lag. (ii) Molecular friction caused by the lag between the formation of magnetic flux behind the magneto motive force that creates it.

I

Impedance	The combination of resistance and reactance in an AC circuit.
Indirect injection (IDI)	Describes any of a number of methods of injecting fuel to an engine outside of the cylinder. This may be to an intake tract in the intake manifold or to a cell adjacent to the cylinder such as a pre-combustion chamber.
Indicated horsepower	Gross power produced in the engine cylinders often arrived at by calculation and always greater than *brake power* because it does not factor in pumping and friction losses.
Industry Committee	A committee of industry members who are representative of the province and help to guide the MTCU about apprenticeship issues.
Inertia	In physics, it describes the tendency of a body at rest or in motion to continue that state unless it is changed by an external force.
Inline block	An engine that has all of its cylinders aligned in a straight row.
Insulator	Materials that either prevent or inhibit the flow of electrons: usually nonmetallic substances that contain more than four electrons in their outer shell.
Integral	Whole or combined with another component to act as a single unit.
Isochronous governor	A zero droop governor or one that accommodates no change in RPM on the engine it manages as engine load varies. In electronically managed truck engines, the term is sometimes used to describe engine operation in PTO mode.

J

Jounce	Literally "bump"-used to describe the most compressed condition of a suspension spring.
Journal	The part of an axle or shaft that actually contacts the bearing.
Jumper pipe	A term used to describe the pipes that connect the charge and return galleries with DDC MUIs or with each other in multi-cylinder heads.

K

Kinetic energy	Any energy associated with motion.
Kingpin inclination	Inclination angle of the steering axis to a vertical plane.
Kirchhoff's 1st Law	States that the current flowing into a point or component in an electrical circuit must equal the current flowing out of it.
Kirchhoff's 2nd Law	States that the voltage will drop in exact proportion to the resistance in a circuit component and that the sum of the voltage drops must equal the voltage applied to the circuit; also known as Kirchhoff's Law of voltage drop.

L

Lambda sensor	An exhaust gas sensor used on electronically managed, SI gasoline-fueled engines to signal the ECM the oxygen content in the exhaust gas.
Laminar flow	A condition where the fluid particles move in continuous parallel paths; streamline flow.
Lead acid battery	Standard vehicle battery consisting of lead acid cells in series. Twelve volt batteries have become standard and they can be used in multiples in parallel or series for heavy duty applications.
L-head engine	An in-line engine configuration where the intake and exhaust valve ports are located adjacent to the cylinder in the block. Seldom used in current engines.
Learning outcome	Learning outcomes are discrete statements that describe the elements leading to attainment of the general learning outcome.
Learning content	The learning activities required for the learner to achieve the Learning Outcomes. A comprehensive list of activities to guide the trainer.
Liner protrusion	The amount the liner protrudes above the deck of the block, thus allowing retention when the head is properly torqued.
Logic	(i) The science of reasoning. (ii) Arithmetic and data comparison protocols of a microprocessor.

M

Magnetism	The phenomenon that includes the physical attraction for iron observed in lodestone and associated with electric current flow. It is characterized by fields of force, which can exert a mechanical and electrical influence on anything within the boundaries of that field.
Manometer	A tubular, U-shaped column mounted on a calibration scale. The tube is water or mercury-filled to balance at 0 on the scale and the instrument is used to measure light pressure or vacuum conditions in fluid circuits.
Mechanical efficiency	A measure of how effectively *indicated power* is converted into *brake power;* factors in pumping and friction losses.
Micrometer	A precision instrument for measuring either internal, external, or depth dimensions to within thousands or ten thousands of an inch or millimeter.
Micron	One millionth of a meter or .000039 inch. The term used to

	rate the size of filters for liquids, such as engine oil or hydraulic fluids.
Muffler	An *engine silencer* that uses sound absorption and resonation principles to alter the frequency of engine noise.
Mechanical Unit Injector (MUI)	Cam-actuated, governor-controlled unit injectors used by DDC and Caterpillar.
Multimeter	A test instrument capable of reading volts, amps, and ohms.
Multi-orifii nozzle	A typical hydraulic injector nozzle whose function it is to switch and atomize the fuel injected to an engine cylinder. Consists of a nozzle body machined with the orifii, a nozzle valve, and a spring. Used in most DI diesel engines using port helix injection pumps, MUIs, EUIs, and HEUIs.
Multiplexing	A method of using one communications path to carry two or more signals simultaneously.

N

Nitrogen dioxide	One of the oxides of nitrogen produced in vehicle engines and a significant contributor in the formation of photochemical smog.
Non-ferrous metal	Metals and alloys that contain little or no iron.
Non-volatile RAM	NVRAM-read-write RAM device capable of data retention in cells in a vehicle module after the ignition circuit is opened; also known as KAM
Normal rated power	The highest power specified for continuous operation of an engine.

O

O. Reg.631/94 section 3	Is an Ontario regulation for regulations as they apply to overhead cranes.
OEM	Original equipment manufacturer.
Ohm	A unit for quantifying electrical resistance in a circuit.
Ohm's Law	The formula used to calculate electrical circuit performance. It asserts that it requires 1 v of potential to pump 1 A of current through a circuit resistance of 1 ohm.
Ohmmeter	An instrument for measuring resistance in an electric component or circuit.
Opacity meter	A light extinction means of testing exhaust gas particulate and liquid emission that rates density of exhaust smoke based on the percentage of emitted light that does not reach the sensor, so the higher the percentage reading, the more dense the exhaust smoke.
Orifice	A hole or aperture.
Orifii	Plural of orifice.
Oscilloscope	An instrument designed to graphically display electrical waveforms on a CRT or other display medium.
Otto cycle	The four stroke, spark ignited cycle, patented by Nicolas Otto in 1876 and consisting of induction, compression, power and exhaust strokes.
Overhead camshaft	An engine which locates the valve actuating camshaft(s) in the cylinder head to either directly or indirectly actuate the valves and in some diesel applications, the unit injectors.

Oxy-acetylene	A commonly used cutting, heating, and welding process that uses pure compressed oxygen in conjunction with acetylene fuel.
Oxidation	The act of oxidizing a material; can mean combusting or burning a substance.
Oxides of nitrogen (NOx)	An undesirable compound of nitrogen and oxygen in exhaust gases. Usually produced when combustion chamber temperatures are excessively high.

P

Parallel port valve configuration	Engine cylinder valve arrangement that locates multiple valves parallel to crank centreline permitting equal gas flow through each (assuming identical lift).
Particulate trap	A canister in series with the exhaust piping containing a filtering medium to entrap diesel HC exhaust particulates and in some instances oxidize them.
Pascal's Law	A principle of fluids that states that when pressure is applied to a confined fluid, it is transferred undiminished throughout the fluid.
PC networks	Any of a variety of small personal computers designed for full function in isolation from other units but which may be used to network with other systems.
Piezoelectric Principle	Certain crystals become electrically charged when exposed to pressure, the voltage produced increasing proportionally with pressure rise. Quartz and Rochelle salt crystals have these properties. Combustion pressure sensors may both use the P*iezoelectric Principle.*
Pintle nozzle	A type of hydraulic injector nozzle used in some IDI automobile, small bore diesel engines until recently.
Plenum chamber	A chamber or cavity in which a fluid is held at a pressure above atmospheric or above system mean pressure.
Pneumatics	Branch of fluid power physics dealing with pressure and gas dynamics.
Poppet nozzle	Forward opening injector nozzle valve used on older Caterpillar IDI systems.
Port-helix metering	Consists of a pumping plunger and barrel assembly designed to regulate fuel delivery.
Potentiometer	A three-terminal variable resistor or voltage divider used to vary the voltage potential of a circuit. Commonly used as a throttle position sensor.
Power	The rate of accomplishing work; it is necessarily factored by time.
Practical	The hands-on element of learning in the curriculum document. Apprentice activities develop skills to achieve completion of psychomotor learning outcomes.
Preloading	Process of adjusting a bearing so that it has a mild pressure placed upon it, beyond zero endplay.
Prerequisite	Learning that must be achieved prior to taking a given subject.
Pressure	Force exerted per unit of area.
Pulse width modulation	The shaping of pulses and waveforms for purposes of digital signaling. Acronym PWM is often used.
Pyrometer	A thermocouple type, high temperature sensing device used

	to signal exhaust temperature. Consists of two dissimilar wires (pure iron and constantan) joined at the hot end with a millivoltmeter at the read end. Increase in temperature will cause a small current to flow, which is read at the voltmeter as a temperature value.

Q

Quenching	Process of dipping a heated object into water, oil, or other substance to quickly reduce its temperature.
Quiescent Combustion	Non-turbulent flame propagation characteristic of slow running diesel engines that are direct injected.

R

Radial	A line at right angles to a shaft, cylinder, etc., Centerline.
RAM	Random access memory. Electronically retained "main memory."
Rated power	The highest power specified for continuous operation.
Rated speed	The RPM at which an engine produces peak power.
Reluctor	Term describing a number of devices that use magnetism and motion to produce an AC voltage-a pick-up coil.
Rebound	Reactive response of a spring, the opposite of jounce.
Reportable Subject	(i) A clustering or grouping of related or like learning outcomes. (ii) A standalone learning unit with a distinct start and end. (iii) A course or module.
Reserve Capacity	The amount of time a battery can produce an acceptable current when not charged by the alternator.
Rheostat	A two terminal, variable resistor.

S

SAE	Society of Automotive Engineers.
SAE horsepower	A structured formula used to calculate brake horsepower data that can be used for comparison purposes.
Scoring	Scratch/gouge damage to a surface finish.
Semiconductor	A substance, such as silicon, that acts as a conductor or insulator, depending on its operating condition and application.
Semi-floating axle	A drive axle design in which the axle shaft imparts drive to the wheel and supports the vehicle weight.
Sensor	A term that covers a wide range of command and monitoring input (ECM) signal devices.
Shunt winding	A wire coil that forms an alternate path through which electrical current can flow.
s.i.	système international d'unités. A measure in metric units.
Silicon	A non metallic element found naturally in silica, silicone dioxide in the form of quartz.
Silicon-controlled rectifier	Function similarly to a bipolar transistor with a fourth semiconductor layer; used to switch DC.
Spark ignition (SI)	Any gasoline-fueled, spark-ignited engine usually using an Otto cycle principle.
Specific gravity	A relative weight of a given volume of a specific material as compared to an equal volume of water.

Spiral gear	A winding helical protrusion or thread machined to a shaft, as in a worm gear.
Static electricity	Accumulated electrical charge not flowing in a circuit.
Stoichiometric Ratio	The exact ratio of reactants participating in a reaction required to complete the reaction. Most often used in the context of explaining the mass of air required to completely combust a fuel.
Supercharger	Technically any device capable of providing manifold boost, but in practice used to refer to gear-driven blowers such as the Rootes blower.
Sulfur	An element present in most crude petroleums, but refined out of most current highway fuels. During combustion, it is oxidized to sulfur dioxide, and classified as a noxious emission.
Sulfur dioxide	The compound that is formed when sulfur is oxidized that is the primary contributor to sulfurous type smog. Vehicles contribute little to sulfurous smog problems due to the use of low sulfur fuels.
Supplemental Restraint System (SRS)	An emergency inflatable air bag system designed to enhance crash safety.
Swept Volume	The volume displaced in a cylinder as a piston moves from BDC to TDC.
Synthetic Oils	Petroleum based oils that have been chemically compounded by polymerization and other processes.

T

TDC	Top dead centre of an engine.
Tensile strength	Widely used term denoting the required unit stress to cause material separation. In ferrous alloys, tensile strength usually exceeds yield strength by about 10%. Measured in force per unit area, psi.
Theory	The theoretical hours listed in the curriculum document that represent learning in the cognitive domain, the thinking portion of the training.
Thermal Efficiency	Ratio of brake power to that of the calorific value (heat energy potential) of a material failure caused by engine performance.
Thermistor	A commonly used temperature sensor that is supplied with a reference voltage and by using a temperature sensitive variable resistor, signals back to the ECM portion of it.
Thrust faces	A term used to describe loading of surface area generally but most often of pistons. When the piston is subject to cylinder gas pressure there is a tendency for it to cock (pivot off a vertical centerline) and load the contact faces off its axis on the pin.
Torque	Twisting effort or force. Torque does not necessarily result in accomplishing work.
Torque rise	The increase in torque potential designed to occur in a diesel engine as it is lugged down from the rated power RPM to the peak torque RPM, during which the power curve remains relatively flat. High torque rise engines are sometimes described as constant horsepower engines.
Training Standards	Training standards are created by the MTCU with the Industry

	Committee and are intended to be used by the apprentice, instructors, and companies as a "blueprint" for on-the-job training, or as a prerequisite for government certification.
Transducer	A device that coverts energy from one power form to another for instance, a physical pressure value to an electrical pressure value.
Trunk piston	A single piece piston usually constructed of aluminum alloy.
Turbocharger	A turbine device that utilizes exhaust pressure to increase the air pressure going into the cylinders. Used particularly in reference to movement of air in the cylinder and combustion chamber.
Turbulence	A violent irregular movement or agitation of a fluid or gas. Violent swirling motion. Fuel injection provided some turbulence. Additional turbulence is provided by the design features of the combustion space.
Turbulent Flow	A condition where the fluid particles move in random paths rather than in continuous parallel paths.
Two-stroke cycle	An engine that requires one complete revolution of the crankshaft to fire each piston once. An engine requiring only one complete revolution of the crankshaft to complete the cycle of events.

U

Unit injector	A diesel fuel injector which receives fuel at charging pressure and performs the functions of metering, creating injection pressure values and atomizing fuel-usually directly to the engine cylinder. Mechanically or electronically controlled, mechanically or hydraulically actuated.
Universal joint	A flexible joint that permits changes in driving angles between a driving and driven shaft.
Urea	the chief solid component of mammalian urine; synthesized from ammonia and carbon dioxide and used as fertilizer and in animal feed and in plastics

V

Valve timing	Crank angle locations in the cycle when the valves are open and closed.
Valve train	The sum of the components responsible for actuating a valve, extending from the cam profile to the valve itself.
V-engine	Engine configuration in which the cylinders are arranged so that their axes form a V. Described by the angle, most commonly, 45, 60, and 90 degrees.
Volatility	The ability of a liquid to evaporate. Gasoline has greater volatility than diesel fuel.
Volute	A snail-shaped diminishing sectional area such as used in turbocharger geometry.
Viscosity	Denotes the fluidity of a liquid.
Viscosity Index	A measure of a liquid's fluidity at a specific temperature-diminishes as temperature drops and vice versa.
Viscous damper	An engine vibration damper consisting of disc shaped housing containing a fluid medium (silicon gel) and a solid inertia ring; uses fluid friction to dampen torsional oscillation.

Voltmeter	Instrument for testing charge differential or voltage in a circuit.
Volumetric efficiency	Engine breathing efficiency. Extent to which end gases are purged from an engine cylinder, usually expressed as a percentage of new charge to cylinder volume. A ratio of mass not volume. Seldom 100% in naturally aspirated engines, can be greater than 100% in boosted engines.

W

Wastegate	A valve that vents excess exhaust gas to limit the amount of boost delivered by a turbocharger.
Watt's Law	Formula for computing unknown power, voltage, or current in a circuit by using two known factors to find the unknown value.
Wet liners	Cylinder block liners that have direct contact with the water jacket and therefore must support cylinder combustion pressures and seal the coolant to which they are exposed.
Wheatstone bridge	A galvanometer that bridges an electrical circuit to give a resistance reading.

Y

Yield strength	The stress loading required to permanently deform a material-automotive construction materials, especially steels, are classified by yield strength rating.

Z

Zenor diode	Specialty diode designed to conduct with a reverse bias current after a specific voltage value is reached.