ONTARIO COLLEGE OF TRADES

ORDRE DES MÉTIERS DE L'ONTARIO

Apprenticeship Curriculum Standard

Truck and Coach Technician

Level 2

Trade Code: 310T

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 Truck and Coach curriculum (T&C) level 2 has been developed in keeping with the prescribed Ministry of Training, Colleges and Universities (MTCU) Training Standards, which apply to the Truck and Coach Technician apprenticeship. The curriculum layout used provides an opportunity to cross-reference the 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 Truck and Coach apprentice.

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

Truck & Coach Technician

Level 2

Program Summary of Reportable Subjects – Level 2

Reportable Subjects	Total	Theory	Practical
S1285.0 Trade Practices and Auxiliary Systems	32	14	18
S1286.0 Engine Systems	40	28	12
S1287.0 Electrical Systems	40	23	17
S1288.0 Fuel Systems	24	16	8
S1289.0 Vehicle Management Electronics and Emission Systems	16	12	4
S1290.0 Drive Train	40	26	14
S1291.0 Steering, Suspension and Brake Systems	48	31	17
Total	**240**	**151**	**89**

Number: **S1285**

Reportable Subject: **Trades Practices and Auxiliary Systems**

Duration: Total 32 hours Theory 14 hours Practical 18 hours

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

Co-requisites: None

1.1 Electric Arc, MIG and TIG Welding

21 Total Hours Theory: 8 hours Practical: 13 hours

1.2 Information Accessing and Shop Communications

5 Total Hours Theory: 2 hours Practical: 3 hours

1.3 Cabs and Controls Systems

4 Total Hours Theory: 2 hours Practical: 2 hours

1.4 Truck Trailer and Articulating Coach Combinations

2 Total Hours Theory: 2 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
40%	60%

Instructional and Delivery Strategies: Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

AC, DC,TIG and combination metal arc equipment	Modems and network cards
Special safety equipment	Internet access
Approved welding areas or booth	OEM data hub access
Ventilating equipment	Reader programmers
Personal computers	ESTs

S1285.1 Electric Arc and MIG Welding

Duration: Total 21 hours Theory 8 hours Practical 13 hours

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

Cross-Reference to Training Standard:

TCT 5135, 5144, 5145

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to perform downhand welding repairs and installations on vehicle chassis components and identify the characteristics of sound welds using electric are and MIG welding process.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.1.1 Explain the purpose and fundamental of shielded metal arc, MIG and TIG welding.

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

1.1.2 Identify the functions, construction, composition, types, styles and application of shielded metal arc, MIG and TIG welding.

[3/0]
- **comparison Arc vs. MIG welding**
- **AC welding transformers**
- **DC rectifiers**
- **arc welding cables**
- **electrode holders**
- **AWS electrode and wire classifications**
- **transformers**
- **rectifiers**
- **MIG welding plant**
- **MIG shielding gases**
- **MIG gun cooling**
- **MIG welding cable and liner**

1.1.3 Describe the principle(s) of operation shielded metal arc, MIG and TIG welding procedures.

[3/0]
- **AC welding transformers**
- **DC rectifiers**
- **arc Welding Polarity**
- **open circuit voltage**

- **closed circuit voltage**
- **electrode and wire coding interpretation**
- **welding characteristics of electrode and wire types**
- **destructive and non-destructive weld testing**
- **analysis of welded coupons**
- **wire speed factors**
- **voltage control factors**
- **MIG transfer methods**
- **short circuit**
- **spray transfer**
- **Tungsten Inert Gas (TIG)**

1.1.4 Perform basic welding using Electric Arc, MIG and TIG welding equipment.

[0/12]
- **electric arc and MIG welding on mild steel**
- **electrode and wire selection**
- **lap welds**
- **fillet welds**
- **butt-welds**
- **flat (down hand) welding techniques**
- **demonstrate**:
  - vertical and horizontal welding techniques
  - arc and MIG welding equipment cleaning and maintenance
  - TIG application

1.1.5 Recommend reconditioning or repairs following manufacturers' procedures on shielded metal arc, MIG and TIG welding.

[1/1]
- **identify personal care and MIG welding safety equipment requirements**
- **high voltage electrical safety hazards**
- **identify types of steel by testing and application**
- **analyze failed welds for cause**
- **identify personal are and MIG welding safety equipment requirements**
- **high voltage electrical safety hazards**
- **identify types of steel by testing and application**
- **analyze failed welds for cause**
- **review requirements for structural and repair welds on truck and coach chassis**
- **identify pressure vessels and non-repairable components**
- **review explosion hazards safety**
- **protecting electronic and mechanical components from arcing damage**

GENERAL PRACTICES

- **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 report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1285.2 Information Accessing and Shop Communications

Duration: Total 5 hours Theory 2 hours Practical 3 hours

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

Cross-Reference to Training Standard:

TCT 5135

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to use manufacturer's service literature, personal computers and networks to locate service and parts information and understand networking protocols of OEM Intranet data hubs.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.2.1 Explain the purpose, functions and application of Information Accessing and Communications Systems

[1/0]
- **introduction to the personal computer (PC), device names and designations**
  - data retention
- **software management formats**
  - directory
  - file naming
  - copy
  - delete
  - rename

1.2.2 Create letters and reports using a PC (personal computer) and universal software programs.

[0/1]
- **introduction to word processing programs**
- **menu structure**
- **naming / saving conventions**
  - search / replace
  - documentation
  - page layout
  - copy/move
- **file/merge/browsed spreadsheets**
- **uses of Internet**
- **OEM intranet systems**

1.2.3 Describe how spreadsheet and word processing software is used in service facilities and how to manage information.

[0/1] - **electronic spreadsheets**
- menu structure
- naming / saving conventions
- documentation
- spreadsheet layout
- copy / move
- file / merge / browse
- search / replace

1.2.4 Demonstrate effective online networking skills and navigate the Internet to search service-related information.

[1/1] - **network etiquette**
- **web browsers**
- **search engines**
- **downloading**
- **e-mail**
- **attachment**
- **links**
- **hyperlinks**
- **data hub access**
- **file sharing software**
- **threaded discussions**
- **using Wikis**

GENERAL PRACTICES

- **safety precautions**
  - file and folder security
  - avoidance of software file clashes
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1285.3 Cabs and Controls Systems

Duration: Total 4 hours Theory 2 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5135, 5140, 5145

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to repair vehicle cab components and fixtures to the manufacturer and statutory standards.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.3.1 Explain the functions, construction and application for Cabs and Control Systems.

[2/0]
- **weather stripping**
- **interior and exterior trim fasteners, adhesives, and retainers**
- **window and regulators**
- **glazing**
- **headlamps**
- **bumpers**
- **wipers and controls**
- **Seats**
- **Supplemental Restraint System (SRS)**
- **Rollover Restraint Systems (RollTek)**
- **mirror assemblies**
- **latches, handles and linkages**
- **hood assemblies**
- **door assemblies**
- **fire suppression**
- **interlock systems**
  - school bus safety
  - transit bus safety
  - trailer and tanker unload safety

1.3.2 Identify inspection and testing and adjustment procedures for cabs and control systems

[0/2]
- **fit (water and dust tight)**
- **appearance**
- **noise location and repair (squeak and rattle)**
- **headlamp alignment**
- **interlock system (school bus safety)**
- **hood assemblies**
- **door assemblies**
- **wipers and controls**

- **supplemental restraint systems**
- **rollover restraint systems**
- **mirrors assemblies**

GENERAL PRACTICES

- **safety precautions**
  - electrostatic discharge precautions
  - grounding precautions
  - eye protection
- **communications**
  - information accessing
  - practical report
  - 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

S1285.4 Truck Trailer and Articulating Coach Combinations

Duration: Total 2 hours Theory 2 hours Practical 0 hours

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

Cross-Reference to Training Standard:

TCT 5135, 5144, 5145, 5147

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to describe the different types of truck and coach rig configuration used in highway applications and access information to determine legal vehicles by weight, height and length.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

1.4.1 Explain the purpose and fundamentals of truck rig configurations and articulating coaches.

[0.5/0]
- **articulation**
- **bridge formula**

1.4.2 Identify the functions, types, styles and application of tractor-trailer configurations and articulating coaches.

[0.5/0]
- **A, B, C and D trains**
- **full- and semi-trailers**
- **articulation**
- **upper couplers**
- **coupling mechanisms**
- **steerable and self-steering / lift axles**
- **articulated transit buses**
- **class designations of buses**

1.4.3 Describe the factors and principles of:

[1/0]
- **bridge formula**
- **weight over axle calculations**
- **Gross Vehicle Weight Rating (GVWR)**
- **Gross Combined Weight Rating (GCWR)**
- **rig designation**
- **total vehicle length**
- **statutory lane sizing**
- **statutory length and height sizing**

GENERAL PRACTICES

- **safety precautions**
  - electrostatic discharge precautions
  - grounding precautions
  - eye protection
- **communications**
  - information accessing
  - practical report
  - 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: S1286

Reportable Subject: **Engine Systems**

Duration: Total 40 hours Theory 28 hours Practical 12 hours

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

Co-requisites: None

2.1 Diesel Cylinder Heads and Valve Trains

17 Total Hours Theory: 12 hours Practical: 5 hours

2.2 Diesel Engine Cylinder Block Assemblies

17 Total Hours Theory: 12 hours Practical: 5 hours

2.3 Gasoline/Alternate Fueled Engines

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
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Hydromechanical diesel engines	Electronic diesel engines
Gasoline/alternate fueled engines	Internet access
Assortment of diesel engine subcomponents	OEM data hub access
Ventilating equipment	Special safety equipment
Personal computers	ESTs

S1286.1 Diesel Cylinder Heads and Valve Trains

Duration: Total 17 hours Theory 12 hours Practical 5 hours

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

Cross-Reference to Training Standard:

TCT 5139, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principle of operation, diagnose and repair diesel engine cylinder heads and valve trains.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.1.1 Explain the purpose and fundamentals of diesel cylinder heads and valve trains.

[2/0]
- **engine theory**
- **cylinder breathing**
- **gas dynamics**
- **thermodynamics**
- **cooling systems**

2.1.2 Identify the functions, construction, composition, types, styles and application of diesel cylinder heads and valve trains.

[4/0]
- **cylinder head castings**
- **valves**
- **cross flow configurations**
- **parallel port configurations**
- **cylinder head castings**
- **valves**
- **cross flow configurations**
- **parallel port configurations**
- **seats**
- **valve rotators**
- **guides**
- **seals**
- **springs**
- **valve trains**
  - rocker assemblies
  - push rods
  - lifters
  - compression brake mounting
  - variable valve timing mounting
- **camshafts**
  - cylinder block mounted

  - overhead
  - double overhead
  - drive mechanisms
- **injector sleeves and fuel manifolds**
  - hydraulic
  - TP
  - EUI
  - HEUI
  - EHI

2.1.3 Describe the principle(s) of operation of diesel cylinder heads and valve trains using both assembled and disassembled components.

[6/0]
- **cylinder head castings and integral components**
- **valves**
  - seats
  - rotators
  - guides
  - seals
  - springs
- **rocker assemblies**
- **volumetric efficiency**
- **breathing efficiencies**
- **cross flow**
- **parallel port design**
- **valve trains**
- **push rods**
- **lifters**
- **camshafts**
  - overhead
  - double overhead
  - dampening mechanisms
- **drive mechanisms**
- **cylinder head cooling**
- **cylinder head lubrication**
- **injector sleeves**

2.1.4 Perform inspection, testing and diagnostic procedures on diesel engine cylinder heads and valve trains.

[0/2]
- **hot and cold hydrostatic testing**
- **interpret valve timing diagrams**
- **set valve timing**
- **perform overhead adjustments**
- **verify true top dead center**
- **injector sleeve leakage tests**
- **check valve height and seating**
- **check cylinder head warp age**

2.1.5 Recommend reconditioning or repairs following manufacturer's procedures on diesel engine cylinder heads and valve trains.

[0/3]
- **dismantle and reassemble cylinder heads**
- **demonstrate/ perform**
  - valve dressing
  - seat installation
  - seat to valve fit
  - valve guide service
  - injector sleeve replacement
  - measuring cylinder head
  - measuring valve train components
  - cylinder head replacement procedure

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - 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

S1286.2 Diesel Engine Cylinder Block Assemblies

Duration: Total 17 hours Theory 12 hours Practical 5 hours

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

Cross-Reference to Training Standard:

TCT 5139

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principle of operation, diagnose and repair diesel engine cylinder block assemblies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.2.1 Explain the purpose and fundamentals of diesel engine cylinder block assemblies.

[2/0]
- **engine block and power train assemblies**
- **bore**
- **stroke**
- **engine displacement**

2.2.2 Identify the functions, construction, composition, types, styles and application of diesel engine cylinder block assemblies.

[4/0]
- **cylinder block**
- **sleeves**
- **top deck surface**
- **counter bore**
- **flywheel**
- **vibration dampers**
- **crankshaft**
- **connecting rods**
  - cracked/ fractured rod technology
  - off set big end
- **piston pins**
- **pistons**
  - aluminum trunk style
  - articulating
  - cross-head
  - steel trunk
- **piston cooling nozzles**
- **bearings**
- **camshaft**
- **crankshaft**
- **combustion chambers**
- **direct injection**

- **gear train**
  - gear train plates

2.2.2 Describe the principle(s) of operation of diesel engine cylinder block assemblies using assembled and disassembled components.

[5/0]
- **cylinder block**
  - sleeved
  - parent bore
  - torque twist limitation
- **sleeves**
  - wet
  - dry
  - mid stop
- **top deck surface**
- **counter bore**
- **flywheel**
  - single mass
  - dual mass
- **vibration dampers**
- **crankshaft**
- **connecting rods**
- **piston pins**
- **pistons**
- **combustion chambers**
- **direct injection requirements**
- **counter balance device**

2.2.4 Perform inspection, testing and diagnostic procedures on diesel engine cylinder block assemblies.

[0/3]
- **measuring / serviceability checks on:**
- **crankshaft**
- **piston**
- **sleeve (liner)**
  - protrusion
  - fit
- **cylinder block**
- **block bore**
- **liner bore**
- **thread condition**
- **crack detection techniques**
  - magnetic flux testing
  - dye penetrant
- **rod side clearance and alignment**
- **ring side clearance and end gap**
- **piston cooling jet alignment**
- **crankshaft**
  - endplay
  - bearing clearances
  - surface condition

- throw radii
- mains radii
- oil hole chamfer
- measuring practices

2.2.5 Recommend reconditioning or repairs following manufacturers' procedures on diesel engine cylinder block assemblies.

[1/2]
- **cleaning diesel engine cylinder blocks**
  - oil passages
  - coolant passages
  - external surfaces
- **outline block machining practices**
- **major component reconditioning procedures**
- **assembly procedure**
- **bearings**
- **pistons**
- **rings**
- **valves**
- **camshafts**
- **crankshafts**
- **deck damage**
- **piston cooling jets**
- **cylinder liners**
- **parent bores**
- **lubrication failures**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - rotting components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
- **communications**
  - information accessing
  - practical report
  - 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

S1286.3 Gasoline / Alternate Fuel Engines

Duration: Total 6 hours Theory 4 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5737, 5139, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair gasoline engines.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

2.3.1 Explain the purpose and fundamentals of gasoline and alternate fuel engines and compare with diesel engines.

[0.5/0]
- **bore**
- **stroke**
- **engine displacement**
- **mechanical efficiency**
- **indicated power**
- **thermal efficiency**
- **volumetric efficiency**

2.3.2 Identify the functions, construction, and application of gasoline and alternate fuel engines.

[1/0]
- **lubrication**
- **cooling**
- **induction**
- **exhaust**
- **fuel systems**
  - gasoline
  - propane
  - compressed natural gas (CNG)
- **fuel sub-systems**
- **emission control devices**
- **spark ignition**
- **combustion chambers**

2.3.3 Describe the principle(s) of operation of gasoline and alternate fuel engines using assembled engines and components.

[2.5/0]
- **lubrication**
- **cooling**
- **induction**
- **exhaust**
- **fuel systems**
- **air fuel ratio**
- **fuel sub-system**
- **emission**
- **combustion chambers**
- **thermal efficiency**

2.3.4 Perform inspection, testing and diagnostic procedures on gasoline and alternate fuel engines.

[0/1]
- **identify types of gasoline and alternate fuel engines**
- **outline service procedures**
- **air inlet restriction**
- **fuel pressure**
- **compression**
- **identify engine serial and code date**

2.3.5 Recommend reconditioning or repairs following manufacturers' procedures on gasoline and alternate fuel engines.

[0/1]
- **outline OEM requirements for servicing different engines**
- **locate procedure for engine service in OEM service literature**
- **outline procedure for servicing cooling systems, fuel, oil and air filters on gasoline and alternate fuel engines**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - rotating components
  - hazards of spring tension
  - wire and grinding wheels
  - cleaning agents
  - hazards of pressurized fuel storage/delivery systems
  - explosion hazards of liquid and gaseous fuels
- **communications**
  - information accessing
  - practical report
  - 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: S1287

Reportable Subject: **Electrical Systems**

Duration: Total 40 hours Theory 23 hours Practical 17 hours

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

Co-requisites: None

3.1 Heavy Duty Batteries

8 Total Hours Theory: 5 hours Practical: 3 hours

3.2 Heavy Duty Cranking Circuit

10 Total Hours Theory: 6 hours Practical: 4 hours

3.3 Interpreting Heavy Duty Electrical Circuit Schematics

6 Total Hours Theory: 2 hours Practical: 4 hours

3.4 Truck and Coach Auxiliary Electrical Components

6 Total Hours Theory: 4 hours Practical: 2 hours

3.5 Electronics Fundamentals

10 Total Hours Theory: 6 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:

Analog and digital AVRs	Sealed wiring connector repair kits
Electronic service tools (ESTs) and PCs	Internet access
Digital multimeters (DMMs)	OEM data hub access
Load tester	Special safety equipment
Oscilloscopes and lab scopes	Battery conductance testing equipment

S1287.1 Heavy Duty Batteries

Duration: Total 8 hours Theory 5 hours Practical 3 hours

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

Cross-Reference to Training Standard:

TCT 5136, 5137

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy-duty batteries.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.1.1 Explain the purpose and fundamentals of heavy-duty batteries.

[1/0]
- **internal resistance factors**
- **specific gravity**
- **state of charge**
- **chemical action**
- **temperature factors**

3.1.2 Identify the functions, construction, composition, types, styles and application of heavy-duty batteries.

[2/0]
- **maintenance free batteries**
- **gelled electrolyte batteries**
- **Heavy duty battery classifications**
- **Heavy duty battery cable classifications**
- **deep cycle batteries**
  - absorbed glass matt (AGM)
  - gel cell
- **Lithium Ion Batteries**
- **Nickel Metal Hydride (NmMH)**
- **ultra-capacitors**

3.1.3 Describe the principle(s) of operation of heavy-duty batteries.

[2/0]
- **internal resistance ratings**
- **cranking requirements**
- **analyzing battery performance**
- **series and series-parallel battery banks**
- **inverters**
- **deep cycle batteries**

  - absorbed glass matt (AGM)
  - gel cell
- **Lithium Ion (LiOn)Batteries**
- **Nickel Metal Hydride (NmMH)**
- **ultracapacitors**

3.1.4 Perform inspection, testing and diagnostic procedures on heavy-duty batteries.

[0/2]
- **visual inspection**
- **state of charge**
- **surface discharge**
- **load test**
- **high rate discharge**
- **temperature adjustments**
- **hydrometer / refractometer test**
- **capacitance testing**
- **electrochemical impedance spectroscopy (EIS) testing**

3.1.5 Recommend reconditioning or repairs following manufacturers' procedures on heavy-duty batteries.

[0/1]
- **maintenance**
- **state of charge**
- **storage**
- **activation**
- **charging procedures**
- **cleaning precautions**
- **boost and boost generator charge precautions**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and face protection
  - battery gas venting
  - electrocution risks
  - hazardous chemical disposal
  - battery recycling
- **communications**
  - information accessing
  - practical report
  - 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

S1287.2 Heavy Duty Cranking Circuit

Duration: Total 10 hours Theory 6 hours Practical 4 hours

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

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty cranking circuits.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.2.1 Explain the purpose and fundamentals of a heavy duty cranking circuit.

[1/0]
- **permanent magnets**
- **electromagnetism**
- **Ohm's law**
- **Watt's law**
- **torque and wattage**
- **counter-electromotive force (CEMF)**
- **centrifugal force**
- **voltage drop**
- **batteries**

3.2.2 Identify the functions, construction, and application of a heavy duty cranking circuit.

[2/0]
- **cranking motors**
- **hybrid start systems**
- **series**
- **series-shunt**
- **series-parallel**
- **field windings**
- **armature**
- **commutator**
- **brushes**
- **springs**
- **permanent magnet**
- **gear reduction**
- **relays**
- **solenoids**
- **drives**
- **series-parallel switching**
- **electromechanical & electronic cranking controls**

3.2.3 Describe the principle(s) of operation of heavy duty cranking circuit.

[3/0]
- **electromagnetic principles**
- **electric motor principle**
- **cranking motors**
- **series**
- **series-shunt**
- **series-parallel**
- **CEMF effect on current flow**
- **temperature effect on load and torque output**
- **high current demands**
- **relays**
- **solenoids**
- **drives**
  - overrunning clutch
  - disengagement protection
- **over-crank protection**
- **automatic lockout and disengagement**

3.2.4 Perform inspection, testing and diagnostic procedures on heavy duty cranking circuit components.

[0/3]
- **outline cranking circuit diagnostic sequence**
- **perform voltage drop testing**
- **cranking no-load bench tests**
- **test relays and solenoids**
- **solenoid pull-in & hold-in test**
- **electronic cranking circuit analysis**

3.2.5 Recommend reconditioning or repairs following manufacturers procedures on heavy duty cranking circuits.

[0/1]
- **disassemble and reassemble cranking motors**
- **perform component failure analysis**
- **outline removal and replacement of:**
  - relays
  - solenoids
  - cranking motors

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical report
  - 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

S1287.3 Interpreting Heavy Duty Electrical Circuit Schematics

Duration: Total 6 hours Theory 2 hours Practical 4 hours

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

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of Electrical circuit schematics and use them to diagnose and repair truck and coach electrical systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.3.1 Explain the purpose and fundamentals of heavy-duty electrical circuit schematics.

[0.5/0]
- **electricity**
- **electronics**
- **series circuits**
- **parallel circuits**
- **series parallel circuits**
- **electrical schematics**
- **schematic symbols**
- **icons**

3.3.2 Identify the functions, types, styles and application of heavy-duty electrical circuit schematics.

[0.5/0]
- **OEM electrical schematics**
- **digital schematics**
- **interactive schematics**

3.3.3 Describe how to interpret heavy-duty electrical circuit schematics.

[1/0]
- **symbols**
- **valley forge**
- **Deutsche International (DIN)/ISO**

3.3.4 Perform inspection, testing and diagnostic procedures on heavy duty electrical systems using circuit schematics.

[0/3]
- **perform circuit analysis using OEM schematics**
- **test operational and malfunctioning electrical circuit components**

3.3.5 Recommend reconditioning or repairs following manufacturers' procedures on heavy-duty electrical circuit schematics.

[0/1]
- **diagnose common circuit malfunctions**
- **access OEM circuit schematics**
- **CD-ROM**
- **OEM data hubs**
- **service manuals**
- **aftermarket electronic information systems**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and face protection
  - battery gas venting
  - explosion precautions
- **communications**
  - information accessing
  - practical report
  - 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

S1287.4 Truck and Coach Auxiliary Electrical Components

Duration: Total 6 hours Theory 4 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5136, 3137, 5140, 5145

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair truck and coach auxiliary electrical components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.4.1 Define the purpose and fundamentals of auxiliary electrical components.

[1/0]
- **electricity**
- **electronics**
- **interpretation of schematics**
- **wiring gauge numbers (American wire gauge, ~~and~~ SI & SAE, colours**
- **SAE codes & numbering**
- **temperature effects of current flow through conductors**
- **SAE wire specifications and applications**
- **candlepower specifications**

3.4.2 Identify the functions, construction, and application of auxiliary electrical components.

[1/0]
- **wiring – core & insulation**
- **lighting**
- **signal circuits**
- **headlamp circuits**
- **light circuits**
- **wiper circuits**
- **gauges and instruments**
- **sending unit**
- **auxiliary motors**

3.4.3 Describe the principle(s) of operation of auxiliary electrical components.

[2/0]
- **wiring circuits**
- **sealed electronic connectors**
- **lighting**
- **signal circuits**
- **headlamp circuits**
- **light circuits**
- **wiper circuits**

- **horns**
- **mirror heaters**
- **sending unit**
- **auxiliary motors**

3.4.4 Perform inspection, testing and diagnostic procedures on auxiliary electrical components.

[0/1]
- **electrical flow charts**
- **demonstration of wiper and warning system component tests**
- **identify circuit protection devices**
- **cycling breakers**
- **non-cycling breakers**
- **sequential troubleshooting techniques**
- **high impedance digital multimeter**
- **reader / programmers**
- **PCs**
- **circuit damage precautions**
- **electrostatic discharge**

3.4.5 Recommend reconditioning or repairs following manufacturers' procedures on auxiliary electrical components.

[0/1]
- **remove and replace electrical accessories**
- **recondition auxiliary electrical components**

GENERAL PRACTICES

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

S1287.5 Electronics Fundamentals

Duration: Total 10 hours Theory 6 hours Practical 4 hours

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

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the fundamental of electronics and diagnose malfunctions in electronically managed circuits and components

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

3.5.1 Explain the purpose and fundamentals or electronics.

[1/0]
- **review of circuit calculations**
- **Ohm's law**
- **voltage drop calculation**
- **semiconductor materials**
- **waveforms**
- **voltage spike control**
- **static electricity**
- **electrostatic discharge**
- **shielding**
- **grounding**

3.5.2 Identify the functions, construction and application of electronic devices.

[2/0]
- **diodes**
  - rectifying
  - zener
  - light emitting
  - photo
- **transistors**
  - PNP
  - NPN
- **sensors**
  - reluctors
  - thermister
  - piezoelectric
  - piezoresistive
  - variable resistor
  - rheostat
  - potentiometers
  - hall effect

- **optical devices**
- **capacitors**

3.5.3 Describe the principle(s) of operation of electronic devices.

[3/0]
- **diodes**
  - forward and reverse bias
  - current control
  - spike suppression
- **transistors**
  - forward and reverse bias
  - PNP and NPN
  - gate controls
  - switching
  - amplification
- **capacitors**
- **sensors**
  - reluctors
  - thermistor
  - piezoelectric
  - piezoresistive
  - variable resistor
  - rheostat
  - potentiometers
  - thermocouple
  - O_2 and NOx
- **binary logic**

3.5.4 Perform inspection and testing procedures on electronic devices.

[0/3]
- **diodes**
- **transistors**
- **capacitors**
- **resistors**
- **potentiometer**
- **variable capacitance sensors**
- **reluctors**

3.5.5 Recommend reconditioning or repairs following manufacturers' procedures for vehicle electronic devices.

[0/1]
- **moisture protection**
- **component identification**
- **explosion hazards**
- **control of electrostatic discharge**
- **control of component damage**

GENERAL PRACTICES

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

Number: S1288

Reportable Subject: **Fuel Systems**

Duration: Total 24 hours Theory 18 hours Practical 6 hours

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

Co-requisites: None

4.1 Principles of Diesel Fuel Injection Helix Metering

4 Total Hours Theory: 4 hours Practical: 0 hours

4.2 Electronic Unit Injector (EUI) Systems

10 Total Hours Theory: 6 hours Practical: 4 Hours

4.3 Engine Governing

4 Total Hours Theory: 3 hours Practical: 1 hour

4.4 Gasoline & Alternate Fuel Injection System

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
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Diesel engine with EUI fuel system	Gasoline, propane, and CNG fuel delivery components
Single actuator EUIs	Internet access
Dual actuator EUIs	OEM data hub access
Disassembled EUI components	EUI calibration code programming software
EUI extraction and timing tools	PCs and ESTs

S1288.1 Principles of Diesel Injection

Duration: Total hours 4 Theory 4 hours Practical 0 hours

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

Cross-Reference to Training Standard:

TCT 5138, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principle of high pressure diesel fuel injection.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.1.1 Explain the purpose and fundamentals of high pressure diesel fuel injection.

[1/0]
- **hydraulics**
- **pressure and sectional area**
- **fuel chemistry**
- **requirements for combustion of liquid fuels**
- **combustion characteristics**
- **direct injection**
- **emissions**

4.1.2 Identify the functions and application of high pressure diesel fuel injection systems.

[1/0]
- **fuel management systems**
- **fuel pressurization**
- **hydraulic and mechanical pumps**
- **combustion chambers**
- **products of combustion**
- **harmful emissions**
- **carbon footprint**
- **relationship between cylinder pressure and crank angle mechanics**

4.1.3 Describe the principle(s) of operation and objectives of high pressure diesel fuel injection.

[2/0]
- **pumping action**
- **effective stroke control**
- **droplet sizing**
- **injection timing**
- **ignition timing**
- **pressure management**
- **phases of combustion**
- **effects of timing on emissions**
- **effects of timing on power output**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - high pressure / skin penetration
  - ventilation
  - explosion hazard of atomized fuel
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1288.2 Electronic Unit Injector (EUI) Systems

Duration: Total 12 hours Theory 7 hours Practical 5 hours

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

Cross-Reference to Training Standard:

TCT 5138, 5140, 5141

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation diagnose and repair Electronic Unit Injector (EUI) diesel fuel systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.2.1 Explain the purpose and fundamentals of electronic unit injector systems.

[1/0]
- **electricity**
  - electronics
  - computers
  - digital electronics
  - input and output circuits
- **characteristics of cam geometry**

4.2.2 Identify the functions, construction, and application of electronic unit injector systems.

[3/0]
- **ECM: chassis and engine controllers**
- **switching apparatus**
- **multiplexed ECMs**
- **interface modules**
- **injector driver units**
- **EUI components (electronic unit injectors)**
  - solenoid cartridge valves
  - tappet, plunger and barrel assemblies
  - hydraulic nozzle assemblies
  - electro-hydraulic nozzles
- **distinguishing factors between different EUI systems**

4.2.3 Describe the principle(s) of operation of electronic unit injector systems.

[3/0]
- **injector driver units**
- **actuation voltage spiking**
- **electronic unit injectors**
  - control solenoids
  - injection pumping components
  - hydraulic nozzles
  - electro-hydraulic nozzles
- **effective stroke control**
- **injection pressure control**
- **multi pulse injection**
- **communication protocols**
- **interface protocols**
- **vehicle and engine controllers**
- **customer data programming**
- **proprietary data programming**
- **default modes**
- **tattletale / audit trail logging**
- **injector duty cycle/pulse width**
- **injector response time**

4.2.4 Perform inspection, testing and diagnostic procedures electronic unit injector systems.

[0/3]
- **customer data programming**
- **proprietary data programming**
- **sequential troubleshooting using OEM text**
- **circuit malfunctions**
- **cylinder performance testing**
- **snapshot test**
- **proprietary data programming**

4.2.5 Recommend reconditioning or repairs following manufacturers' procedures on electronic unit injector systems.

[0/2]
- **procedure for diagnosing electronic malfunctions**
- **procedure for diagnosing hydro-mechanical malfunctions**
- **procedure for replacing and reprogramming ECMs**
- **demonstrate proprietary data download procedures**
- **procedures for removing and replacing EUIs**
- **program EUI flow rate to an ECM**
- **program customer engine and chassis data to an ECM**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - high pressures / residual pressure
  - polarity precautions
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1288.3 Engine Governing

Duration: Total 4 hours Theory 3 hours Practical 1 hour

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

Cross-Reference to Training Standard:

TCT 5138, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of diesel engine governing.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.3.1 Explain the purpose and fundamentals of diesel engine governing.

[1/0]
- **diesel engine fundamentals**
- **diesel fuel system fundamentals**
- **diesel fuel sub-systems**
- **hydraulics**
- **centrifugal force**
- **pressure, force and flow area**

4.3.2 Identify the functions, and application of diesel engine governing.

[1/0]
- **mechanical governors electronic control module (ECM) governor algorithms**
- **hydraulic governors**
- **limiting speed (LS)**
- **variable speed (VS)**
- **isochronous**
- **throttle position sensors**
- **thrust collars**
- **fuel control mechanisms**
- **servos**
- **hydraulic media and lubrication**
- **mechanical governors**

4.3.3 Describe the principle(s) of diesel engine governing.

[1/0]
- **speed sensing**
- **load request and engine derate**
- **limiting speed drivability**
- **variable speed drivability**
- **isochronous (PTO) modes**
- **peak torque fuelling**
- **rated speed fuelling**
- **programmed engine droop**
- **programmed road speed droop**
- **smart cruise factors**
- **idle, peak torque, rated, and high idle speeds**
- **governing algorithm**
- **off-balance fuelling**
- **fuel maps**
- **programming options**

4.3.4 Perform inspection, testing, programming and diagnostic procedures on diesel engine governors.

[0/1]
- **plot torque rise profile on a graph using data from an engine under load**
- **use an EST to program governor options such as LS or VS**
- **interpret a diagnostic flow chart**
- **analyze audit trails**
- **outline procedure for fuel map download**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - high pressure / skin penetration
  - ventilation
  - explosion hazard of atomized fuel
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data management systems
    - service records
    - microfiche
    - service information systems
    - electronic formats
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1288.4 Gasoline/Alternate Fuel Injection Systems

Duration: Total 6 hours Theory 4 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5138, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principle of operation, diagnose and repair gasoline and alternate fuel injection systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

4.4.1 Explain the purpose and fundamentals of gasoline and alternate fuel injection systems.

[1/0]
- **engine theory**
- **fuel chemistry**
  - gasoline
  - propane
  - CNG
- **hydraulics**
- **combustion**
- **Otto cycle**
- **electronics**

4.4.2 Identify the functions, construction and application of gasoline and alternate fuel injection systems.

[1/0]
- **fuel tanks & reservoirs**
- **sending unit / pump assemblies**
- **pressure regulators**
- **accumulators**
- **fuel rail**
- **throttle bodies**
- **Electrically-actuated injectors**
- **electronic management circuit**
- **oxygen sensors**
- **input circuit**
- **ECMs**

4.4.3 Describe the principle(s) of operation off gasoline and alternate fuel injection systems.

[2/0]
- **fuel system flow**
- **indirect injection principles**
- **direct injection principles**

- **open and closed loop factors**
- **noxious emission control criteria**

4.4.4 Perform inspection, testing and diagnostic procedure on gasoline and alternate fuel injection systems.

[0/1]
- **identify system components**
- **use an EST to retrieve fault codes**
- **performance test a engine**

4.4.5 Recommend reconditioning or repairs following manufactures' procedures on gasoline and alternate fuel injection systems.

[0/1]
- **injector balance testing**
- **remove and install injectors**
- **check injection circuit for flow restrictions**
- **outline safe methods of locating explosive gas leakage**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - high pressure / skin penetration
  - ventilation
  - explosion hazards of atomized fuel
  - hazards of pressurized fuel storage
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1289

Reportable Subject: **Vehicle Electronic Management and Emissions Systems**

Duration: Total 16 hours Theory 12 hours Practical 4 hours

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

Co-requisites: None

5.1 Using Electronic Service Tools

5 Total Hours Theory: 3 hours Practical: 2 hours

5.2 Vehicle Computer Fundamentals

4 Total Hours Theory: 4 hours Practical: 0 hours

5.3 Electronic input circuit components

7 Total Hours Theory: 5 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
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Functional electronically controlled diesel engines	Multiplexed truck for diagnostics
Assortment of command and monitoring sensors for bench testing	Internet access
ECM and driver units	OEM data hub access
Electronic service tools (ESTs) and OEM software	Sealed electronic connector repair kits
Personal computers	Ground straps

S1289.1 Using Electronic Service Tools (ESTs)

Duration: Total 5 hours Theory 3 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5135, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to use generic and proprietary ESTs and PCs to read, troubleshoot and reprogram vehicle electronic systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.1.1 Explain the purpose and fundamentals of electronic service tools (ESTs).

[1/0]
- **digital multimeters (DMMs)**
- **generic ESTs**
- **proprietary ESTs**
- **personal computers (PCs)**
- **online service information systems**
- **diagnostic software**
- **breakout Ts & boxes**
- **labscopes**

5.1.2 Identify the functions, construction and application of ESTs and manufacturer software.

[1/0]
- **digital multimeters (DMMs)**
- **generic reader / programmers**
- **proprietary reader / programmers**
- **personal computers (PCs)**
- **breakout Ts & boxes**
- **scope meter**

5.1.3 Describe the principle(s) of operation of ESTs

[1/0]
- **digital multimeters**
  - accuracy
  - resolution
  - display interpretation
  - voltage, amperage, continuity and resistance measurements
  - scope meter
- **generic reader / programmers**
  - software cartridges
  - upgrading PROM
- **proprietary reader / programmers**
  - upgrading software
- **personal computers**
  - communications adapters
  - SAE communications protocols
  - data retention media
  - connections

5.1.4 Perform readout, diagnostic and networking tasks using ESTs and shop PC units including:

[0/2]
- **select and use ESTs to troubleshoot live and simulated circuit conditions**
- **internet familiarization**
- **saving data**
- **identify hard and soft EST malfunctions**
- **distinguish between electrical and software performance problems on malfunctioning ESTs**
- **outline procedures for updating ESTs**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - high pressure / residual pressure
  - polarity precautions
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - microfiche
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1289.2 Vehicle Computer Fundamentals

Duration: Total 4 hours Theory 4 hours Practical 0 hours

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

Cross-Reference to Training Standard:

TCT 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the basics of a vehicle computer control system and how it functions to process information and produce outcomes.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.2.1 Explain the purpose and fundamentals of onboard computers, input devices and output actuators.

[1/0]
- **analog / digital computers**
- **binary systems**
- **digital computers**
- **logic gates**
- **data links**
- **networking**
- **fiber optics**

5.2.2 Identify the functions, construction and application of vehicle computers.

[1/0]
- **input sensors**
- **central processing unit (CPU)**
- **main memory (RAM)**
- **non-volatile data retention**
  - ROM
  - PROM
  - EEPROM
- **output actuators**

5.2.3 Describe the principle(s) of operation of vehicle computers.

[2/0]
- **analog to digital converters**
- **signal filtration**
- **Central Processing Unit (CPU)**
- **processing cycle**
- **baud rate (Clock speed)**
- **logic sequencing**
- **main memory (RAM)**
- **non-volatile data retention**
  - ROM
  - PROM
  - EEPROM
- **ECM intergral outputs**

GENERAL PRACTICES

- **safety precautions**
  - potential lifting hazards
  - eye, breathing, hearing and hand protection
  - electric shock precautions
  - polarity precautions
  - electrostatic discharge precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - paper trail
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1289.3 Electronic Input Circuit Components

Duration: Total 7 hours Theory 5 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5136, 5137, 5140

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation diagnose and repair electronic input circuit components.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

5.3.1 Explain the purpose and fundamentals of electronic input circuit components.

[1/0]
- **electronics**
- **computer basics**
- **electronic schematic interpretation**

5.3.2 Identify the function, construction and application of electronic input circuit components.

[1/0]
- **reference voltage**
- **thermistor**
- **potentiometers**
- **variable capacitance sensors**
- **pulse wheel generators**
- **rotary hall-effect sensors**
- **linear hall-effect sensors**
- **electromechanical switches**
- **smart (ladder) switches**
- **semiconductors**
- **optical sensors**
- **gasoline exhaust gas sensors**
- **piezoelectric**
- **piezioresistive**
  - wheatstone bridges
- **pressure differential (Delta) sensors**

5.3.2 Describe the principle(s) of operation of electronic input circuit components.

[3/0]
- **reference voltage**
- **thermistor**
- **potentiometers**
- **variable capacitance sensors**
- **pulse wheel generators**
- **hall-effect sensors**
- **optical sensors**
- **gasoline exhaust gas sensors**
- **switches**
- **piezoelectric**
- **piezoresistive**
- **wheatstone bridges**

5.3.4 Perform inspection, testing and diagnostic procedures on electronic input circuit components.

[0/1]
- **test functional and malfunctioning input circuit components**
- **diagnose performance conditions produced malfunctioning input circuit components**

5.3.5 Recommend reconditioning or repairs following manufacturers' procedures on electronic input circuit components.

[0/1]
- **outline procedure for replacing defective input circuit components**
- **performance test replaced input circuit components**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and face protection
  - battery gas precautions
  - explosion precautions
- **communications**
  - information accessing
  - practical report
  - 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: S1290

Reportable Subject: **Drive Trains**

Duration: Total 40 hours Theory 26 hours Practical 14 hours

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

Co-requisites: None

6.1 Pull-Type Clutches and Flywheel Assemblies

6 Total Hours Theory: 4 hours Practical: 2 hours

6.2 Multiple Countershaft Manual Transmission and Auxiliary Sections

17 Total Hours Theory: 10 hours Practical: 7 hours

6.3 Multiple Speed and Double Reduction Drive Axle Assemblies

5 Total Hours Theory: 4 hours Practical: 1 hour

6.4 Power Divided Tandem Drive Assemblies

4 Total Hours Theory: 3 hours Practical: 1 hour

6.5 Electronically-Automated Standard Transmissions

8 Total Hours Theory: 5 hours Practical: 3 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:

Assortment of pull type clutches	Assortment of drive axle carriers
Pot and plate type flywheels	Power-divided tandem drive set
Compounded twin countershaft transmissions	OEM data hub access
Electronically automated transmissions and clutches	Internet access
Personal computers	ESTs

S1290 .1 Pull-Type Clutches and Flywheel Assemblies

Duration: Total 6 hours Theory 4 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation diagnose and repair pull-type clutches and flywheel assemblies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.1.1 Explain the purpose and fundamentals of pull type clutches and flywheel assemblies.

[1/0]
- **clamping force**
- **mechanical advantage**
- **laws of levers**
- **hydraulics**
- **static and sliding friction**
- **coefficient of friction**
- **friction and heat**
- **centrifugal force**

6.1.2 Identify the function, construction, composition, types, styles, and application of pull type clutches and flywheel assemblies.

[1/0]
- **clutch disengagement and engagement**
- **flywheel**
- **pressure plate(s)**
- **clutch friction disc assemblies**
- **hubs**
- **input shaft**
- **release bearing**
- **clutch brake**
- **mechanical release mechanisms**
- **hydraulic release mechanism**
- **adjustment – free**
- **air cylinder / cables linkage**
- **bus and coach controls**
- **flywheel housings**
- **bell / clutch housing**

6.1.3 Describe the principle(s) of operation of pull type clutches and flywheel assemblies.

[2/0]
- **double disc clutches**
- **clutch control system**
- **adjustment – free**
- **linkage geometry**
- **release bearing assembly**
- **clutch brake**
- **flywheel**
- **pilot bearing**
- **clutch / input shaft**
- **pressure plate(s)**
- **heat dissipation**
- **coefficient of friction**
- **friction media effects**
- **friction discs**
- **dampening**
- **hubs**
- **clutch housing**
- **clutch assembly alignment**
- **power flow**

6.1.4 Perform inspection, testing and diagnostic procedures on pull-type clutches and flywheel assemblies.

[0/1]
- **adjustment**
- **visual inspection**
- **test clutch and control operation**
- **diagnose clutch condition**
- **lubrication practices**
- **hydraulics**
- **fluid levels**
- **clutch alignment**
- **housing alignment**
- **performance testing**
- **sub-component inspection**
- **identify causes of failure**

6.1.5 Recommend reconditioning or repairs following manufacturers' procedures on pull-type clutches and flywheel assemblies.

[0/1]
- **familiarization with manufacturers' service literature and specifications**
- **performs clutch adjustment**
- **remove and replace clutch assembly**
- **remove and replace flywheel**
- **machining practices**
- **performance testing**
- **identify causes of failure**
- **measurement of components and assembly**
- **clutch assemblies overhaul procedures**
- **removal and replacement techniques**

GENERAL PRACTICES

- **safety precautions**
  - eye, hand, breathing and hearing protection
  - use of hoist and stands
  - safe vehicle operation
- **communications**
  - pilot shaft
  - information accessing
  - practical report
  - technical service bulletins
  - data retention system
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1290.2 Multiple Countershaft Manual Transmission and Auxiliary Sections

Duration: Total 17 hours Theory 10 hours Practical 7 hours

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

Cross-Reference to Training Standard:

TCT 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair countershaft manual transmission and auxiliary sections.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.2.1 Explain the purpose and fundamentals of multiple countershaft manual transmission and auxiliary sections.

[2/0]
- **mechanical advantage**
- **laws of levers**
- **torque**
- **input / output rotational speed**
- **gear ratios**
- **shafts, splines and gears**
- **clutching mechanisms**
- **shifting mechanisms**
- **pneumatics**
- **range shifting**
- **range system shifting**
- **splitter system shifting**
- **power flows**
- **thrust loads**
- **lubrication**

6.2.2 Identify the functions, construction, composition, types, styles and application of multiple countershaft manual transmission and auxiliary sections.

[3/0]
- **clutching mechanisms**
- **case / housing**
- **gears**
- **shafts**
- **twin countershafts**
- **triple countershafts**
- **bearings and bushings**
- **spacers and thrust washers**
- **seals and gaskets**
- **shifting mechanisms**
- **air filters**
- **air pressure regulators**
- **master control valve**
- **range control valve**
- **splitter control valve**
- **deep reduction control valve**
- **slave air valve**
- **range cylinder assembly**
- **splitter cylinder assembly**

6.2.3 Describe the principle(s) of operation of multiple countershaft manual transmission and auxiliary sections.

[5/0]
- **clutching mechanisms**
- **gears**
- **matching**
- **timing**
- **shafts**
- **twin countershafts**
- **triple countershafts**
- **power flows**
- **lubrication systems and oil pumps**
- **thrust control**
- **bearing and bushings**
- **sealing**
- **shifting mechanisms**
- **pneumatic system operation**
- **range system air flows**
- **splitter shifter air flows**

6.2.4 Perform inspection, testing and diagnostic procedures on multiple countershaft manual transmission and auxiliary sections.

[0/2]
- **visual inspection**
- **performance test**
- **pneumatic pressure testing**
- **temperature testing**
- **thrust measurement**
- **fluid level and condition**
- **verify power flow**
- **shaft timing**

6.2.5 Recommend reconditioning or repairs following manufacturers' procedures for multiple countershaft manual transmission and auxiliary sections.

[0/5]
- **outline procedure for checking lubricant levels**
- **outline recommended lubricant change intervals and procedure**
- **verify lubricant types and application**
- **transmission removal, disassembly, reassembly, timing and replacement procedures**
- **auxiliary section removal, disassembly, reassembly timing and replacement procedures**
- **air pressure adjustment**
- **pneumatic valve and cylinder replacement procedure**
- **o-ring replacement**
- **air filter replacement**
- **system contaminant flushing**
- **perform failure analysis**
  - shock failure
  - fatigue failures
  - torsional failures
  - surface failures

GENERAL PRACTICES

- **safety precautions**
  - eye, breathing, hearing and hand protection
  - dismantling
  - use of drifts
  - control of snap ring or circlip removal
  - hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1290.3 Multiple Speed and Double Reduction Drive Axle Assemblies

Duration: Total 5 hours Theory 4 hours Practical 1 hour

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

Cross-Reference to Training Standard:

TCT 5142, 5143

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair multiple speed and double reduction drive axle assemblies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.3.1 Explain the purpose and fundamentals of multiple speed and double reduction drive axle assemblies.

[1/0]
- **mechanical advantage**
- **laws of levers**
- **torque**
- **input / output rotational speed**
- **gear ratios**
- **loading characteristics**
- **differential action**
- **thrust loads**
- **power flow**
- **bearing preloads**
- **lubrication**

6.3.2 Identify the functions, construction, composition, types, styles and application of multiple speed and double deduction drive axle assemblies.

[1/0]
- **drive axle assemblies**
  - planetary two-speed
  - planetary double-reduction
  - double-reduction helical
  - two-speed double-reduction helical
- **housing**
- **carriers**
  - removable
- **planetary gearing**
- **planetary wheel end assemblies**
- **helical gearing**
- **differential gearing**
- **differential locks**
- **axle shafts**

    - full floating
- **pneumatic shift system**
- **electric shift system lubricants**

6.3.3 Describe the principle(s) of operation of multiple speed and double reduction drive axle assemblies.

[3/0]
- **drive axle assemblies**
    - planetary two-speed
    - planetary double-reduction
    - double-reduction helical
    - two-speed double-reduction helical
- **housing**
- **carriers**
    - removable
- **planetary gearing**
- **planetary wheel end assemblies**
    - helical gearing
    - differential gearing
    - differential locks
    - pneumatic shift system
    - electric shift system
- **lubricants**

6.3.4 Perform disassembly, inspection, testing, diagnostic and reassembly procedures on multiple speed and double reduction drive axle assemblies.

[0/0.5]
- **disassemble**
- **reassemble**
    - pinion bearing preload
    - pinion depth
    - carrier bearing preload
    - backlash
- **noise analysis**
- **temperature analysis**
- **visual inspection**
- **performance testing**
- **lubricant level and condition**
- **shift problems**
- **shift control operation**
- **failure analysis**

6.3.5 Recommend reconditioning or repairs following manufacturers' procedures on multiple speed and double reduction drive axle assemblies.

[0/0.5]
- **outline procedure for checking lubricant levels**
- **outline recommended lubricant change levels**
- **verify lubricant type and application**
- **carrier removal, disassembly, reassembly and replacement procedure**
- **failure analysis to identify**
  - shock failures
  - fatigue failures
  - torsional failures
  - surface failures
  - spinout failures
  - operational overloading
  - temperature effects
- **demonstrate procedures for setting**
  - pinion bearing preload
  - pinion depth
  - carrier bearing preload
  - drive gear set backlash
- **procedure for checking**
  - drive gear set contact patterns
  - drive gear set backlash
  - thrust screw adjustment
- **shift unit and overhaul**

GENERAL PRACTICES

- **safety precautions**
  - eye, breathing, hearing and hand protection
  - dismantling
  - use of drifts
  - control of snap ring or circlip removal
  - hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1290.4 Power Divided Tandem Drive Assemblies

Duration: Total 4 hours Theory 3 hours Practical 1 hour

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

Cross-Reference to Training Standard:

TCT 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose, and repair power divided tandem drive assemblies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.4.1 Explain the purpose and fundamentals of power divider tandem drive assemblies.

[1/0]
- **torque distribution**
- **differential action**
- **inter-axle differential action**
- **power flow**
- **lubrication**
- **differential lock**

6.4.2 Identify the function, construction, composition, types, styles and application of power divided tandem drive assemblies.

[1/0]
- **housings**
- **differential gearing**
- **differential locks**
- **interaxle differentials**
  - centrifugal type
  - differential type
- **interaxle differential lock**
  - centrifugal engagement
  - pneumatic engagement

6.4.3 Describe the principle(s) of operation of power divided tandem drive assemblies.

[1/0]
- **inter-axle differential action**
- **differential gearing**
- **lubrication**
- **lubricants**
- **inter-axle differentials**
  - centrifugal type
  - differential type
- **inter-axle differential locks**
  - pneumatic engagement

6.4.4 Perform inspection, testing and diagnostic procedures on power divided tandem drive assemblies

[0/0.5]
- **noise analysis**
- **temperature analysis**
- **visual inspection**
- **performance testing**
- **lubricant level and condition**
- **failure analysis**

6.4.5 Recommend reconditioning or repairs following manufacturers' procedures on power divided tandem drive assemblies

[0/0.5]
- **outline procedure for checking lubricant levels**
- **outline lubricant change procedure**
- **verify lubricant type and application**
- **power divider removal, disassembly, reassembly**
- **replacement procedure**
- **failure analysis**
- **shock failures**
- **fatigue failures**
- **torsional failures**
- **surface failures**
- **spinout failures**
- **operational overloading**
- **temperature effects**

GENERAL PRACTICES

- **safety precautions**
  - eye, breathing, hearing and hand protection
  - dismantling
  - use of drifts
  - control of snap ring or circlip removal
  - hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1290 .5 Electronically Automated Standard Transmissions

Duration: Total 8 hours Theory 5 hours Practical 3 hours

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

Cross-Reference to Training Standard:

TCT 5137, 5140, 5142

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair electronically automated standard transmissions.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

6.5.1 Explain the purpose and fundamentals of electronically controlled standard transmission.

[1/0]
- **clutching and shifting characteristics**
- **digital electronics**
- **input and output circuits**

6.5.2 Identify the function, construction, composition, types, styles and application of electronically controlled standard transmissions.

[2/0]
- **electronic shift control system**
- **input signals**
  - vehicle (output) speed sensor
  - engine speed sensors
  - input shaft speed sensor
  - main shaft speed sensor
  - rail sensors
  - shift selector
- **output actuators**
- **electronic range valve**
- **electronic splitter control**
- **shifter module**
- **rail motors**
- **gear motors**
- **connectors and harnesses**
- **ECM / ECU**

6.5.3 Describe the principle(s) of operation of electronically controlled standard transmissions.

[2/0]
- **input signals**
- **vehicle (output) speed sensor**
- **engine speed and load sensor**
- **input shaft speed sensor**
- **main shaft speed sensor**
- **rail position sensors**
- **shift selector**
- **output actuators**
  - electronic splitter control
  - electronic range valve
  - shifter module
  - rail motors
- **connectors and harnesses**
- **ECM / ECU**
- **customer data reprogramming**
- **default modes**
- **data link protocol**

6.5.4 Perform inspection, testing and diagnostic procedures on electronically controlled standard transmissions.

[0/2]
- **visual inspection**
- **digital multimeter**
- **EST**
- **interpretation of schematics**
- **electrical**
- **pneumatic**
- **fault code interpretation**
- **retrieving and clearing fault codes**
  - EST
  - digital diagnostic display

6.5.5 Recommend reconditioning or repairs following manufacturers' procedures and perform assigned operations on electronically controlled standard transmissions.

[0/1]
- **performance testing**
- **identify harness and connector failures**
- **sensor / actuator replacement**
- **ECM / ECU replacement**
- **maintenance / repair precautions**

GENERAL PRACTICES

- **safety precautions**
  - eye, hand, breathing, hearing and foot protection
  - lifting precautions of transmissions
  - clamping and holding
  - compressed springs
  - use of air to dry and test components
  - oil pressure
  - hoist and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

Number: S1291

Reportable Subject: **Steering, Suspension and Brake Systems**

Duration: Total 48 hours Theory 31 hours Practical 17 hours

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

Co-requisites: None

7.1 Truck and Coach Air Brake Theory

8 Total Hours Theory: 8 hours Practical: 0 hours

7.2 Truck and Coach Air Brakes Applications

4 Total Hours Theory: 0 hours Practical: 4 hours

7.3 Heavy Duty Hydraulic and Air-Over-Hydraulic Brakes

4 Total Hours Theory: 3 hours Practical: 1 hour

7.4 Truck and Coach Tire and Wheel Assemblies

8 Total Hours Theory: 4 hours Practical: 4 hours

7.5 Wheel End Assemblies

4 Total Hours Theory: 2 hours Practical: 2 hours

7.6 Truck and Coach Mechanical Suspensions

10 Total Hours Theory: 7 hours Practical: 3 hours

7.7 Truck and Coach Air Suspension Theory

4 Total Hours Theory: 4 hours Practical: 0 hours

7.8 Truck and Coach Suspension System Repairs

6 Total Hours Theory: 2 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
70%	30%

Instructional and Delivery Strategies:
Lecture and assignment work

Reference Materials:
O.E.M. Equipment Documentation

Recommended Minimum Equipment:

Operational air brake equipped trucks and buses	Assortment of pneumatic and mechanical suspension components
Trucks equipped with mechanical suspensions	Disassembled S-cam and air disc brake
Trucks/trailers equipped with air suspensions	Precision measuring equipment
Wheel end service equipment	brake balance diagnostic software
HD jacking and hoisting equipment	ESTs

S1291.1 Truck and Coach Air Brake Theory

Duration: Total 8 hours Theory 8 hours Practical 0 hours

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

Cross-Reference to Training Standard:

TCT 5149, 5150

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation of truck and coach air brake systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.1.1 Explain the purpose and fundamental of air brake system

[2/0]
- **law of levers**
- **mechanical advantage**
- **coefficient of friction**
- **pneumatic principles**
- **pressure volume relationship**
- **spring brake chamber calculations**
  - potential energy
  - liner force
  - leverage
- **brake torque**
- **brake friction factors**
- **electrical and electronics basics**
- **effects of vehicle load and speed**

7.1.2 Identify the function, construction, composition, types, styles and application of air brake systems.

[2/0]
- **foundation assemblies**
  - S-cam
  - wedge
  - disc
- **actuator chambers**
- **air compressors**
- **air dryers**
- **tanks**
- **reservoirs**
- **control devoices**
- **air governors**
  - mounting location
  - heat protection
  - coach heat resistant
- **pressure regulators**
- **pressure protection valves**
- **safety valves**
- **control valves**
- **application**
- **interlock**
- **anti-compounding**
- **relay**
- **quick release**
- **combination**
- **check valves**
- **ratio**
- **two-way**
- **inversion**
- **bob-tail proportioning**
- **tractor protection valves**
- **service, emergency relay**
- **slack adjusters**
  - manual
  - automatic
- **hoses, lines and fittings**
- **CMVSS 121 requirements**

7.1.3. Describe the principle(s) of operation of truck and coach air brake systems.

[4/0]
- **foundation assemblies**
  - S-cam
  - wedge
  - disc
- **friction media**
- **actuator chambers**
  - standard
  - coach chambers (DD3)
  - long stroke
- **air supply system**
- **compressors**
- **tanks**
- **air dryers**
- **reservoirs**
- **circuit protection valves**
- **pressure signaling valves**
- **gauge pressure application**
- **air control devices**
- **air governors**
- **pressure regulators**
- **pressure protection valve**
- **safety valves**
- **control valves**
  - application
  - anti-compounding
  - relay
  - quick release
  - combination
  - check valves
  - two-way
  - inversion
- **dash control valves**
- **tractor protection valves**
- **bobtail proportioning**
- **interlock valves and protection**
- **service emergency relay**
- **slack adjusters**
  - manual
  - automatic
- **brake timing and balance**
- **lines, hoses and fittings**
- **factors affecting friction surface face failure**
- **brake circuit operation**
  - brake fade
  - inversion factors
  - failure modes
- **effects of load transfer**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - hoist, jack and stand use
  - spring chamber handling
  - air pressure protection
  - brake dust
  - grease on friction materials
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention system
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1291.2 Truck and Coach Air Brakes Applications

Duration: Total 4 hours Theory 0 hours Practical 4 hours

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

Cross-Reference to Training Standard:

TCT 5149, 5150

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to diagnose and repair truck and coach air brake systems according to manufacturer and statutory safety standards.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.2.1 Explain inspection, testing and diagnostic procedures on air brake systems.

[0/2]
- **foundation brakes**
- **stroke length**
- **automatic slack adjusters**
- **disarm spring brake chambers according to recommended safe practice**
- **outline procedure for air compressor, air dryer, air receiver testing**
- **test and adjust governors**
- **test control valves for recommended operation**
- **brake torque balance**
- **brake timing**
- **outline brake disc and drum machining operations**
- **interpret pneumatic schematics**
- **interpret statutory inspection safety criteria**

7.2.2 Identify reconditioning or repairs following manufacturers' procedures and perform assigned operations on air brake systems.

[0/2]
- **foundation components**
  - relining
  - machining practices
  - perform complete wheel-end service
  - S-cam foundation
  - disc brake foundation
- **pneumatic circuit components**
  - electrically actuated systems (brake by wire)
- **perform air brake adjustment according to recommended procedures**
- **readjust air governors**
- **interpreting statutory specifications**
- **failure analysis**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - hoist, jack and stand use
  - spring chamber handling
  - air pressure protection
  - brake dust
  - grease on friction materials
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1291.3 Heavy Duty Hydraulic and Air-Over-Hydraulic Brakes

Duration: Total 4 hours Theory 3 hours Practical 1 hour

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

Cross-Reference to Training Standard:

TCT 5149, 5150

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair heavy duty hydraulic and air-over-hydraulic brakes.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.3.1 Explain the purpose and fundamentals of heavy duty hydraulic and air-over-hydraulic brakes.

[0.5/0]
- **law of levers, mechanical advantages**
- **coefficient of friction**
- **hydraulic principles**
- **press volume relationship**
- **actuator / wheel cylinder calculations**
- **potential energy**
- **linear force**
- **leverage**
- **brake torque**
- **brake fiction factors**
- **electrical and electronics basics**
- **effects of vehicle load and speed**

7.3.2 Identify the function, construction, types, and application of heavy duty hydraulic and air-over-hydraulic brakes.

[0.5/0]
- **foundation brake assembly**
- **master cylinder**
- **metering valves**
- **proportioning valves**
- **power assist systems**
- **hydraulic plumbing**
- **wheel cylinders**

7.3.3 Describe the principle(s) of operation of heavy duty hydraulic and air-over-hydraulic brakes.

[2/0]
- **dual circuit hydraulic brake systems**
- **foundation brake assembly**
- **air over hydraulic brake systems**
- **air actuation / management circuit**
- **master cylinder**
- **metering valves**
- **proportioning valves**
- **power assist systems**
- **hydraulic plumbing**
- **wheel cylinders**
- **ABS systems**

7.3.4 Perform inspection, testing and diagnostic procedures on heavy duty hydraulic and air-over-hydraulic brakes.

[0/0.5]
- **identify hydraulic brake system components**
- **identify air over hydraulic brake system components**
- **verify brake system performance**
- **diagnose typical brake failure modes**
- **outline procedure for purging a hydraulic brake system**
- **outline procedure for performing a foundation-brake overhaul / service**
- **describe procedure required to replace the friction facings on brake shoes and pads**

7.3.5 Recommend reconditioning or repairs following manufacturers' procedures on heavy duty hydraulic and air over hydraulic brakes.

[0/0.5]
- **perform failure analysis on failed foundation brake components**
- **determine serviceability of pneumatic and hydraulic circuit components**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - hoist, jack and stand use
  - air pressure protection
  - grease and friction materials
  - electronic system static electricity precautions
  - bending precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1291.4 Truck and Coach Tire and Wheel Assemblies

Duration: Total 8 hours Theory 4 hours Practical 4 hours

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

Cross-Reference to Training Standard:

TCT 5148, 5150

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the operating principles of truck and coach tire and wheel assemblies.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.4.1 Explain the purpose and fundamental of tire and wheel assemblies.

[1/0]
- **centrifugal force**
- **hydra planning**
- **sliding and rolling friction**
- **ferrous and non-ferrous materials**
- **fastener torque**
- **static and dynamic balance**

7.4.2 Identify the functions, construction, composition, types, styles and application of tire and wheel assemblies.

[1/0]
- **tires**
- **materials**
- **radials, bias ply**
- **wide base singles**
- **double sectional steering type**
- **wheel rims**
- **drop centre**
- **semi-drop**
- **three piece flat base (multiple piece)**
- **lock rings**
- **disc wheels**
- **cast spoked wheels**
  - wheel spacers
- **fasteners**
- **hubs**
  - cast spoke
  - steel disc
  - aluminum disc
  - lugs and nuts
- **hub odometers**

- **bearings and retaining locks**
- **tapered roller**
- **washers**
- **lock nuts**
- **lubrication**
- **seals**
  - integral
  - non-integral

7.4.3 Describe the principle(s) of operation of tire and wheel assemblies.

[2/0]
- **tires**
  - radial and bias ply
  - wide base singles
  - double sectional steering type
- **rim sizing details / tire matching**
  - radials and bias ply
  - dual wheels
  - rolling radius
  - tandem axles
- **tire inflation and monitoring systems**
- **nitrogen inflation**
- **wheel rims and lock rings**
- **hubs**
  - cast spoke
  - stud piloted
  - hub piloted
- **fasteners**
- **wheel hub odometers**
- **bearings**
  - tapered roller
  - end play and preload
- **preset**
- **unitized**
- **seals**
  - integral
  - non-integral

7.4.4 Perform inspection, testing and diagnostic procedures on tire and wheel assemblies.

[0/3] **visual inspection for:**
- **tire wear patterns**
- **tire matching**
- **alignment**
- **run-out**
- **check tire tread depth**
- **check bearing condition**
- **check seal condition**
- **remove and replace a wheel and hub assembly according to recommended procedures**
- **perform bearing adjustment according to Technology and Maintenance Council (TMC) procedures**
- **demonstration of seal removal and installation**

7.4.5 Recommend reconditioning or repairs following manufacturers' procedures on tire and wheel assemblies.

[0/1]
- **outline the dismantling and reassembly procedures of tires and rims**
- **outline static and dynamic tire balancing procedures**
- **outline the (TMC) Technology and Maintenance Council recommended wheel adjustment procedures**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - inflating precautions
  - caging of split rim assemblies
  - jack and stand use
- **communications**
  - information accessing
  - practical report
  - 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

S1291.5 Wheel End Assemblies

Duration: Total 4 hours Theory 2 hours Practical 2 hours

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

Cross-Reference to Training Standard:

TCT 5148

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, and be able to diagnose and repair wheel end assemblies.

LEARNING OUTCOMES AND CONTENT

On successful completion, the apprentice is able to:

7.5.1 Explain the history, purpose and fundamentals of wheel end assemblies.

[0.5/0]
- **TMC wheel end practices**
- **bearing failure analysis**
- **tire and rim assemblies**

7.5.2 Describe the principle(s) of operation of low and zero maintenance of wheel end assemblies.

[1.5/0]
- **lubrication**
- **oil**
- **grease**
- **synthetic**
- **API specifications**
- **optimized maintenance**
- **zero maintenance hub assemblies**
- **endplay**
- **preload**
- **preset hubs**
- **unitized**
- **spindle assemblies**

7.5.3 Perform inspection and testing procedures of wheel end assemblies.

[0/1]
- **visual inspection**
- **bearings wear patterns**
- **heat and discoloring**
- **galling**
- **spalling**
- **bearing match**
- **failure analysis**
- **bearing end play**
- **bearing fit**
- **hubs**
- **spindles**

7.5.4 Recommend reconditioning or repairs following manufacturers' procedures on wheel end assemblies.

[0/1]
- **perform bearing adjustment according to manufacturers' recommended procedures**
- **outline TMC wheel end procedure**
- **remove and replace bearings**
  - bearing cleaning precautions
  - preset hubs
- **alternate repair procedure**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - inflating precautions
  - caging of split rim assemblies
  - jack and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1291.6 Truck and Coach Mechanical Suspensions

Duration: Total 10 hours Theory 7 hours Practical 3 hours

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

Cross-Reference to Training Standard:

TCT 5146, 5148

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation, diagnose and repair truck and coach mechanical suspensions

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.6.1 Define the purpose and fundamental of mechanical suspension systems.

[2/0]
- **oscillation**
- **Hooke's law**
- **articulation**
- **equalization**
- **isolation**
- **centre of gravity**
- **vehicle stability**
- **dampening**
- **hydraulics**

7.6.2 Describe the functions, construction, composition, types, styles and application of mechanical suspension systems.

[2/0]
- **leaf springs**
  - constant rate
  - progressive rate
  - auxiliary
  - tandem
  - two stage
- **suspension system components**
  - walking beams
  - radius rods / torque rods
  - equalizers
  - hangers
  - shackles
  - bushings
  - saddles
  - towers
  - u-bolts
  - slipper brackets

- **rubber spring suspension components**
  - tower
  - trunnion
  - restrictor can
  - rubber spring
- **spring mounting hardware**

7.6.3 Explain the principle(s) of operation of mechanical suspension systems.

[3/0]
- **leaf springs**
  - constant rate
  - progressive rate auxiliary
  - tandem
  - two stage
  - deflection rate
  - jounce and rebound
  - oscillation
  - dampening
- **rubber springs**
  - spring rate
  - dynamics
- **stresses**
  - tensile
  - compressional
  - sheer
- **wheel hop and wind up**
- **sprung and unsprung weight**

7.6.4 Perform inspection and testing procedures of mechanical suspension systems.

[0/2]
- **visual inspection**
  - cracks
  - wear
  - rust
- **mountings**
- **leaf integrity and alignment**
- **radius and torque rod bushings**
- **slipper brackets and hangers**
- **equalizer assembly**

7.6.5 Recommend reconditioning or repairs following manufacturers' procedures on mechanical suspension systems.

[0/1]
- **outline procedure for servicing**
  - spring hangers and brackets
  - removing and replacing leaf springs
- **outline assembly of spring packs**
- **outline removal and replacement of equalizers and torque rods**
- **outline removal and replacement of mounting hardware**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - spring tension control
  - hoist, jack and stand use
  - heating precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1291.7 Truck and Coach Air Suspension Theory

Duration: Total 4 hours Theory 4 hours Practical 0 hours

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

Cross-Reference to Training Standard:

TCT 5146, 5148

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to understand the principles of operation of truck and coach air suspension systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.7.1 Explain the purpose and fundamentals of air suspension systems.

[1/0]
- **shock absorbers**
- **deflection of air springs**
- **pneumatics**
- **jounce and rebound**
- **wheel hop and wind up**
- **tensional and compression loading**

7.7.2 Identify the function, construction, composition, types, styles and application of air suspension systems.

[1/0]
- **air springs**
  - bag
  - pedestal
  - jounce blocks
- **auxiliary**
- **tandem**
- **equalizing beam**
- **auxiliary torsion bar**
- **ride height components**
- **combination mechanical/ pneumatic suspensions**
- **shock absorbers types**

7.7.3 Describe the principle(s) of operation of air suspension systems.

[2/0]
- **air springs**
  - bag
  - pedestal
  - jounce blocks
- **auxiliary**
- **tandem**
- **equalizing beam**
- **auxiliary torsion bar**
- **ride height factor**
- **combination mechanical/ pneumatic suspensions**
- **shock absorbers type**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - inflating precautions
  - caging of split rim assemblies
  - jack and stand use
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention systems
    - service records
    - service information systems
    - electronic format
  - current legislated requirements
  - WHMIS
- **mathematics**
  - système international d'unités (s.i.) to Imperial conversion

S1291.8 Truck and Coach Suspension System Repairs

Duration: Total 6 hours Theory 2 hours Practical 4 hours

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

Cross-Reference to Training Standard:

TCT 5146, 5148

GENERAL LEARNING OUTCOME

Upon successful completion, the apprentice is able to diagnose and repair truck and coach suspension systems.

LEARNING OUTCOMES AND CONTENT

Upon successful completion, the apprentice is able to:

7.8.1 Perform inspection, adjustment, testing and diagnostic procedures on truck and coach suspension systems.

[0/3]
- **visual inspection**
- **cracks**
- **wear**
- **rust**
- **bends**
- **twists**
- **test and adjust vehicle ride height**
- **test air springs for leaks and damage**
- **shock absorbers**
  - internal and external oil leaks
  - corrosion
- **tracking and alignment**
- **outline procedure for projecting frame / suspension diagrams**

7.8.2 Recommend reconditioning or repairs.

[2/1]
- **perform height control valve adjustment**
- **outline servicing of:**
  - spring hangers and brackets
  - air valves and height control valves
  - hoses and air springs
  - rubber cushions
  - removing and replacing lead and air springs
- **outline OEM frame and suspension wear limits**
- **outline safety check procedure for frame and suspension system components**

GENERAL PRACTICES

- **safety precautions**
  - eye, hearing, breathing and hand protection
  - spring tension control
  - hoist, jack and stand use
  - heating precautions
- **communications**
  - information accessing
  - practical report
  - technical service bulletins
  - data retention 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

CAS	Collision Avoidance System
CB	Citizen Band
CDI	Capacitor Discharge Ignition
CD-ROM	Compact Disc Read Only Memory
C-EGR	Cooled Exhaust Gas Recirculation
CFC	Chlorofluorocarbons
CI	Compression Ignited
CMVSS	Canadian Motor Vehicle Safety Standard
CNG	Compressed Natural Gas
CPU	Central Processing Unit
CR	Common Rail
CSA	Canadian Standards Association
CVSA	Commercial Vehicle Safety Alliance
CWS	Collision Warning Systems

D

DC	Direct Current
DDC	Detroit Diesel Corporation
DIN	Deutsche Institute fur Normung (German Standards Institute)
DMM	Digital Multimeter
DOS	Disk Operating System
DOT	Department of Transportation
DPF	Diesel Particulate Filter
DTC	Diagnostic Trouble Code

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
EUP	Electronic Unit Pump
EHI	Electrohydraulic Injector
ELC	Extended Life Coolant
EPA	Environmental Protection Act
EST	Electronic Service Tool
EUI	Electronic Unit Injector
EUP	Electronic Unit Pump

F

FACR	Fuel Amplified Common Rail
FHSL	Federal Health and Safety Legislation
FMI	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 (logistics)

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
PLC	Powerline Carrier

PLTT	Powered Lift Truck Technician
PNP	Positive Negative Positive (semi-conductor)
PROM	Programmable Read-Only Memory
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 TMC
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 Closed 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.
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.
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 compensator	Any sensor or device that automatically compensates for 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.
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 colourless, 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 or 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.
Crossflow	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 the chassis data bus.

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

Electrohydraulic injector (EHI)	An electronically switched injector that is opened and closed by the engine ECM on the basis of fueling logic and independent of hydraulic pressure. Used in CR and EUP engines.
Electrohydraulic nozzle	Electronically switched nozzle used in dual actuator EUI: as with the EHI, opening is ECM managed independent of hydraulic pressure.
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.
Endplay	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 or linear 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.
hydromechanical 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 hydromechanical governor terminology, a response lag. (ii) Molecular friction caused by the lag between the formation of magnetic flux behind the magnetomotive 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

Packet	Bit architecture of a multiplex message
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.
Smart	Used to describe components or subsystems with processing capability or direct-controlled by an ECM. Examples: smart cruise/ smart injector.
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	Synthesized ammonia and carbon dioxide used to break down NOx compound bonds into elemental oxygen and nitrogen

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	Defines fluid shear but often used to describe the fluidity of a liquid.
Viscosity Index	A measure of a liquid's resistance to shear 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.