

# Red Seal Occupational Standard

## Truck and Transport Mechanic



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# **Red Seal Occupational Standard**

## **Truck and Transport Mechanic**



Title: Truck and Transport Mechanic

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# Foreword

***The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the Red Seal standard for the Truck and Transport Mechanic trade.***

## Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. Employment and Social Development Canada (ESDC) funds the Red Seal Program, which, under the guidance of the CCDA, develops a national occupational standard for each of the Red Seal trades.

Standards have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and assessment tools for apprenticeship and certification authorities;
- to develop common tools for apprenticeship on-the-job and technical training in Canada;
- to facilitate the mobility of apprentices and skilled workers in Canada;
- to supply employers, employees, associations, industries, training institutions and governments with occupational standards.

Any questions, comments, or suggestions for changes, corrections, or revisions to this standard or any of its related products may be forwarded to:

Trades and Apprenticeship Division  
Apprenticeship and Sectoral Initiatives Directorate  
Employment and Social Development Canada  
140 Promenade du Portage, Phase IV  
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# Acknowledgements

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Special thanks are offered to the following representatives who contributed greatly to the original draft of the standard and provided expert advice throughout its development:

Dallas Andrushak	Manitoba
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This standard was prepared by the Apprenticeship and Sectoral Initiatives Directorate of ESDC. The coordinating, facilitating and processing of this standard were undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of British Columbia, the host jurisdiction for this trade.

# Structure of the Occupational Standard

This standard contains the following sections:

**Methodology:** an overview of the process for development, review, validation and weighting of the standard

**Description of the Truck and Transport Mechanic Trade:** an overview of the trade's duties, work environment, job requirements, similar occupations and career progression

**Trends in the Truck and Transport Mechanic Trade:** some of the trends identified by industry as being the most important for workers in this trade

**Skills for Success Summary:** an overview of how each of the skills for success (formerly called essential skills) is applied in this trade

**Roles and Opportunities for Skilled Trades in a Sustainable Future:** an overarching description of how in the context of climate change, skilled trades play a large role in implementing solutions and adjusting to changes in the world. In addition to highlighting the importance of this awareness, the standard may also contain more details on activities, skills and knowledge elements that are specific to the trade

**Industry Expected Performance:** description of the expectations regarding the level of performance of the tasks, including information related to specific codes, regulations and standards that must be observed

**Language Requirements:** description of the language requirements for working and studying in this trade in Canada

**Pie Chart of Red Seal Examination Weightings:** a graph which depicts the national percentages of exam questions assigned to the major work activities

**Task Matrix and Weightings:** a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard and the national percentages of exam questions assigned to the major work activities and tasks

**Harmonization of Apprenticeship Training:** the aspects of apprenticeship training that participating provinces and territories have agreed upon to substantively align apprenticeship systems across Canada

**Major Work Activity (MWA):** the largest division within the standard that is comprised of a distinct set of trade activities

**Task:** distinct actions that describe the activities within a major work activity

**Task Descriptor:** a general description of the task

**Sub-task:** distinct actions that describe the activities within a task

**Skills:**

**Performance Criteria:** description of the activities that are done as the sub-task is performed

**Evidence of Attainment:** proof that the activities of the sub-task meet the expected performance of a tradesperson who has reached journeyperson level

**Range of Variables:** elements and examples (not all inclusive) that provide a more in-depth description of a term used in the performance criteria and evidence of attainment

**Knowledge:**

**Learning Outcomes:** describes what should be learned relating to a sub-task while participating in technical or in-school training

**Learning Objectives:** topics to be covered during technical or in-school training in order to meet the learning outcomes for the sub-task

**Range of Variables:** elements and examples (not all inclusive) that provide a more in-depth description of a term used in the learning outcomes and learning objectives

**Appendix A – Acronyms:** a list of acronyms used in the standard with their full name

**Appendix B – Tools and Equipment / Outils et équipement:** a bilingual non-exhaustive list of tools and equipment used in this trade

**Appendix C – Glossary / Glossaire:** bilingual definitions or explanations of selected technical terms used in the standard

# Methodology

## Development of the Standard

A draft standard is developed by a broad group of trade representatives, including tradespeople, instructors and employers at a National Workshop led by a team of facilitators. This draft standard breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

## Harmonization of Apprenticeship Training

An analysis of all provinces' and territories' apprenticeship programs is performed and recommendations are made on harmonizing the name of the trade, the hours of training required and the number of levels of training. Provinces and territories consult with their respective industry stakeholders on these elements and revisions are discussed until consensus is reached. Following the development of the workshop draft of the RSOS, participants discuss and come to consensus on the sequence of training topics, as expressed in the new standard. Their sequencing recommendations are reviewed by stakeholders in participating provinces and territories and further discussions are convened to reach consensus and to identify any exceptions.

## Online Survey

Stakeholders are asked to review and validate the activities described in the new standard via an online survey. These stakeholders are invited to participate in this consultation through apprenticeship authorities, as well as national stakeholder groups.

## Draft Review

The RSOS development team forwards a copy of the standard to provincial and territorial authorities who consult with industry representatives to review it. Their recommendations are assessed and incorporated into the standard.

## Validation and Weighting

Participating provinces and territories also consult with industry to validate and weight the document for the purpose of planning the makeup of the Red Seal Interprovincial Examination for the trade. They validate and weight the major work activities (MWA), tasks and sub-tasks, of the standard as follows:

<b>MWA</b>	Each jurisdiction assigns a percentage of questions to each MWA for an examination that would cover the entire trade.
<b>Tasks</b>	Each jurisdiction assigns a percentage of exam questions to each task within a MWA.
<b>Sub-tasks</b>	Each jurisdiction indicates, with a “yes” or “no”, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

The results of this exercise are submitted to the RSOS development team who then analyzes the data and incorporates it into the document. The RSOS provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for MWA and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

The validation of the RSOS is used to identify common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions' industry performs a sub-task, it shall be considered common core. Interprovincial Red Seal Examination questions are limited to the common core sub-tasks identified through this validation process.



## Definitions for Validation and Weighting

<b>yes</b>	sub-task performed by qualified workers in the occupation in that province or territory
<b>no</b>	sub-task not performed by qualified workers in the occupation in that province or territory
<b>NV</b>	standard <u>N</u> ot <u>V</u> alidated by that province or territory
<b>ND</b>	trade <u>N</u> ot <u>D</u> esignated in a province or territory
<b>Not Common Core (NCC)</b>	sub-task, task or MWA performed less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
<b>National Average %</b>	average percentage of questions assigned to each MWA and task in Interprovincial Red Seal Examination for the trade

## Provincial/Territorial Abbreviations

<b>NL</b>	Newfoundland and Labrador
<b>NS</b>	Nova Scotia
<b>PE</b>	Prince Edward Island
<b>NB</b>	New Brunswick
<b>QC</b>	Quebec
<b>ON</b>	Ontario
<b>MB</b>	Manitoba
<b>SK</b>	Saskatchewan
<b>AB</b>	Alberta
<b>BC</b>	British Columbia
<b>NT</b>	Northwest Territories
<b>YT</b>	Yukon Territory
<b>NU</b>	Nunavut

# Description of the Truck and Transport Mechanic Trade

“Truck and Transport Mechanic” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by truck and transport mechanics.

Truck and transport mechanics inspect, diagnose, repair and maintain commercial trucks, emergency vehicles, buses and road transport vehicles. In some jurisdictions, they may also work on commercial trailers and recreation vehicles. Vehicles include electrical (high voltage), hybrid or other fuel alternative vehicles. Truck and transport mechanics work on the structural, mechanical, electrical vehicle systems and components such as engines, cab, chassis and frames, brakes, steering, suspension, drive train, heating, ventilation and air conditioning (HVAC), emissions, fuel systems and hydraulic systems. Many of these systems have electronic controls.

Truck and transport mechanics use specialized tools including hand tools, test meters, hoisting and lifting equipment, staging equipment, welding and cutting equipment, hydraulic equipment, safety equipment, recycle and recovery equipment, and complex electronics and computer diagnostic test equipment.

Truck and transport mechanics are employed in the agricultural, construction, mining, forestry, petrochemical and transportation sectors. They may be employed in small repair shops, motor vehicle dealers, fleet maintenance companies, public transportation companies, government highway departments, railways and construction companies.

Work environments for truck and transport mechanics differ from one job to another. The truck and transport mechanic trade is physically demanding as they frequently work in awkward positions, and must often climb, stoop, crouch and kneel. They also must handle heavy parts and tools. Truck and transport mechanics are sometimes required to work in adverse weather conditions, including extreme cold and heat.

There is some risk of injury involved in working with heavy equipment and power tools. Common occupational hazards are exposure to chemicals and harmful materials, repetitive motion, stored energy releases, high voltages, noises and sharp edges.

Key attributes for individuals entering this trade are mechanical aptitude, manual dexterity, flexibility, good hand-eye coordination and data management (collection, storing and using data securely). With the evolving technology of electrical and hybrid vehicle systems, they must also have a good understanding of computerized machinery, good problem-solving, analytical and computer skills, and the ability to read and understand service manuals. Good communication skills, self learning skills and patience are also important. Other assets include good vision, hearing and sense of smell to diagnose problems.

This standard recognizes similarities or overlaps with the work of automotive service technicians, agricultural equipment technicians, heavy duty equipment technicians, recreation vehicle service technicians and transport trailer technicians.

With experience, truck and transport mechanics act as mentors and trainers to apprentices in the trade. They may also advance to supervisory, service manager and training positions.

In many jurisdictions, truck and transport mechanics require certification to conduct safety inspections on vehicles.

# Trends in the Truck and Transport Mechanic Trade

## Technology

There is an increase in the use of alternative fuel system trucks, such as electric, hybrid, hydrogen fuel cells, natural gas and propane-powered, requiring truck and transport mechanics to be more knowledgeable of these new systems and have the skill set required for their maintenance and repair. Automated transmissions have become more popular replacing the manual transmission. These recent technological changes require truck and transport mechanics to have more intellectual, digital, computer and problem-solving skills.

Advanced driver-assist technologies such as lane signaling systems, lane departure, collision avoidance, and roll stability are rapidly evolving. Into the future, it is expected that there will be more and more autonomous applications, such as platoons of vehicles with a single driver and fully autonomous vehicles.

## Health and Safety

There are advanced health and safety standards in regard to high voltages in electrical and hybrid vehicle systems. There is also potential for increased arc flash hazards that require specialized personal protective equipment (PPE), tools and safety procedures.

## Tools and Equipment

In order to maintain, diagnose and repair hybrid and electric vehicles, specialized tools and repair techniques are necessary. Truck and transport mechanics need to be trained to use these tools and equipment and shops that service these vehicles must have the appropriate specialized equipment to work on them safely.

There is an increase in the use of specialized shop tools to reduce heavy lifting.

## Products and Materials

There are increasingly expensive materials being used for the production of truck systems. After treatment systems require exotic materials to accomplish the emission reduction.

## Environmental

The reduction of harmful exhaust emissions is a priority, which is leading to an increase in the market of alternative fuel system and electric vehicles. Design in vehicles improve their fuel efficiency through improved aerodynamics, reduced weight vehicles, improved tires and tire monitoring systems and electronic control management systems.

There are many hazardous materials used that are detrimental to the environment. Proper protocols for the recycling and disposal of these materials are crucial.

## Legislative and Regulatory

There are legislative requirements set out by the provincial/territorial and federal governments that transport truck mechanics need to follow such as exhaust emissions and chemical disposal.

# Skills for Success Summary

Skills for Success are needed in a quickly changing world for work, learning and life. They are foundational for building other skills and important for effective social interaction. Everyone benefits from having these skills as they help individuals get a job, progress at their current job and change jobs. They also help individuals become active members of their community and succeed in learning.

Through extensive research and consultations, the Government of Canada launched the new Skills for Success model renewing the previous Essential Skills framework to better reflect the needs of the current and future labour market.

The summary presented here is based on existing Essential Skills profiles and will be updated to align with the new [Skills for Success model](#) over time.

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## Reading

Truck and transport mechanics read a variety of paper-based and electronic documents for troubleshooting and servicing, including manufacturers' instructions, technical service bulletins and operating procedures. They read and interpret government regulations that specify vehicle inspection procedures and roadworthiness requirements of trucks and transports. They locate information on labels such as part numbers and serial numbers.

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## Document Use

Truck and transport mechanics interpret technical drawings and flow charts to understand and troubleshoot systems. They study graphed data generated by diagnostic equipment to locate information such as duration, speed and revolutions per minute. Truck and transport mechanics also complete a variety of forms including truck inspection forms. Documents that are used are both paper and electronic formats. Being able to navigate and locate information in various reference material is an important skill.

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## Writing

Truck and transport mechanics write remarks on the complaint/issue, the cause of a problem and the work completed to correct a problem. They may leave reminder notes for co-workers including warnings about defective equipment. Truck and transport mechanics complete pre-job safety checklists. They may also write reports for insurance claims or to report workplace accidents.

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## Oral Communication

Truck and transport mechanics exchange technical repair and troubleshooting information with apprentices, co-workers and manufacturers. They speak with service managers about topics such as work assignments, repair procedures and the condition of tools and equipment. They may speak with customers to respond to questions, gather information about a problem to be fixed or explain the results of inspections and repairs.

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## Numeracy

Truck and transport mechanics analyze and compare a variety of measurements such as energy, dimension, speed, horsepower, temperature and torque to specifications. They calculate the effect that modifications have on vehicle performance. They may use some measurements to determine approximate service life of components.

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## **Thinking**

Truck and transport mechanics evaluate the severity of vehicle defects, assess the conditions of parts and decide what repairs or replacements are to be done. They decide on the most efficient course and sequence of actions to complete a job and ensure the vehicle is safe for operation. An understanding of systems is important in completing the work. Truck and transport mechanics coordinate their work with co-workers if needed.

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## **Working with Others**

Truck and transport mechanics may work independently or with others. They are part of a team which includes other mechanics, service managers and parts and warehouse personnel.

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## **Digital Technology**

Truck and transport mechanics use diagnostic equipment such as scan tools and analyzers to determine the operational condition of components. They use computer equipment to complete repairs, download data from on-board computers and monitor systems. They may use databases to retrieve repair information and technical drawings or to input information about repairs. Truck and transport mechanics use the Internet to access online manuals, technical service bulletins and recall notices. They also use computers for daily tasks which may include e-mail, file management and using fleet management software.

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## **Continuous Learning**

Truck and transport mechanics are continuously learning to keep up with the changes in the industry. They may participate in training seminars to learn about new equipment and how to troubleshoot and perform repairs effectively.

# Roles and Opportunities for Skilled Trades in a Sustainable Future

Climate change affects all of us. Trades play a large role in implementing solutions and adjusting to changes in the world.

Throughout this standard, there may be specific references to tasks, skills and knowledge that clearly show this trade's role in a more sustainable future. Each trade has different roles to play and contributions to make in their own way.

For example:

- Construction tradespeople need to consider the materials they are using, building methods, and improvements to mechanical and electrical installations. There are important changes to codes and standards to help meet the climate change goals and commitments set for 2030 and 2050. Retrofits and new construction of low-energy buildings provide enormous opportunities for workers in this sector. Concepts, such as energy efficiency and regarding buildings as systems are foundational.
- Automotive and mechanical trades are seeing a shift towards the electrification of vehicles and equipment. As a result, new skills and knowledge will be required for tradespeople working in this sector. There are mandates for sales of new light-duty zero-emission vehicles (ZEV) in Canada, with the goal of achieving 100% ZEV sales by 2035. Due to this mandate, the demand for these vehicles is growing quickly among consumers and fleets. With this escalating demand, the need for skilled workers to maintain and repair these vehicles is also increasing.
- In industrial and resource sectors, there is pressure to move towards increased electrification of industrial processes. Many industrial and commercial facilities are also being upgraded to improve energy efficiency in areas such as lighting systems, and new production processes and technologies. There are also opportunities in carbon capture, utilization and storage (CCUS), as well as the production and export of low-carbon hydrogen.
- Trades in the service sector may also need to be aware of responsible sourcing, as well as efficient use of products and materials. New ways of working better are always a part of the job.

There are fast-moving changes in guidelines, codes, regulations and specifications. Many are being implemented for the purpose of energy efficiency and climate change. Those that affect specific trades may be mentioned within the standard. Examples of these guidelines and legislation include:

- The National Energy Code of Canada for Buildings (NECB).
- The Canadian Net-Zero Emissions Accountability Act (CNZEAA).
- programs that encourage sustainable building design and construction such as Leadership in Energy and Environmental Design (LEED) and the Zero Carbon Building (ZCB) standards.
- the Montreal Protocol for phasing out R22 refrigerants.

- energy efficiency programs such as ENERGY STAR.
- principles of the United Nations Declaration for the Rights of Indigenous Peoples pertaining to energy sector development.

Apprentices and tradespeople need to increase their climate literacy and reinforce their own understanding of energy issues and environmental practices. It is important for them to understand why these changes are happening and their effect on trades' work. While individual tradespeople and apprentices may not be able to choose certain elements like; the architectural design of buildings, building material selection, regulatory requirements, use of electric vehicles and technologies, they must understand the impact of using these elements in their work. Impacts include using environmentally friendly products and following requirements related to the disposal and recycling of materials.

In apprenticeship, as well as in ongoing professional development, employers and instructors should encourage learning about these concepts, why they are important, how they are implemented, and the overarching targets they are aiming to achieve.

All in all, it's about doing the work better and building a better world.

# Industry Expected Performance

All tasks must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected and observed. Work should be performed efficiently and to a high quality without material waste or environmental damage. All requirements of employers, engineers, designers, manufacturers, clients and quality control policies must be met. At a journeyperson level of performance, all tasks must be done with integrity, minimal direction and supervision. As a journeyperson progresses in their career, there is an expectation they continue to upgrade their skills and knowledge to maintain pace with industry and promote continuous learning in their trade through mentoring of apprentices.



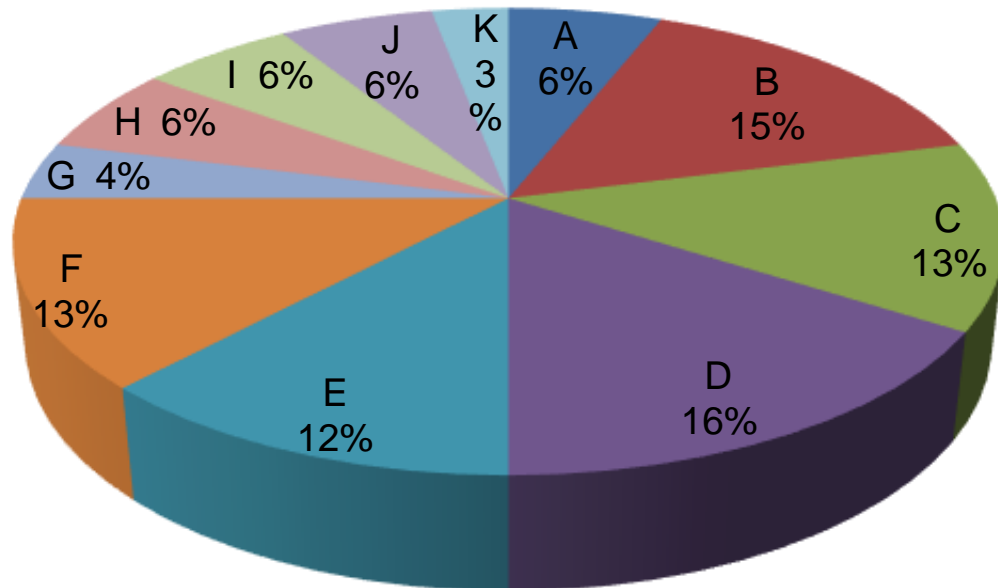
# Language Requirements

It is expected that journeypersons are able to understand and communicate in either English or French, which are Canada's official languages. English or French are the common languages of business as well as languages of instruction in apprenticeship programs.

# Pie Chart

## of Red Seal Examination

### Weightings



MWA A	Performs common occupational skills	6%
MWA B	Services, diagnoses and repairs engines and supporting systems	15%
MWA C	Services, diagnoses and repairs air systems and brake systems	13%
MWA D	Services, diagnoses and repairs electrical and electronic systems	16%
MWA E	Services, diagnoses and repairs drive trains	12%
MWA F	Services, diagnoses and repairs steering, chassis/frames, suspensions, tires, wheels and hubs	13%
MWA G	Services, diagnoses and repairs cabs	4%
MWA H	Services, diagnoses and repairs trailers	6%
MWA I	Services, diagnoses and repairs climate control systems	6%
MWA J	Services, diagnoses and repairs hydraulic systems	6%
MWA K	Services, diagnoses and repairs hybrid and electric vehicles (EV)	3%

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the Tasks. The Interprovincial examination for this trade has 150 questions.

# Truck and Transport Mechanic

## Task Matrix and Weightings

### A – Performs common occupational skills

**6%**

<b>Task A-1 Performs safety-related functions</b> <b>28%</b>	<b>A-1.01 Maintains safe work environment</b>	<b>A-1.02 Uses personal protective equipment (PPE) and safety equipment</b>	<b>A-1.03 Implements specific safety protocols for hybrid and electric vehicles (EV)</b>
<b>Task A-2 Uses and maintains tools and equipment</b> <b>32%</b>	<b>A-2.01 Uses hand, power, measuring, testing, and diagnostic tools</b>	<b>A-2.02 Uses shop equipment</b>	<b>A-2.03 Uses hoisting, lifting and staging equipment</b>
	<b>A-2.04 Uses welding and cutting equipment</b>	<b>A-2.05 Uses electronic devices and systems for diagnostics and programming</b>	
<b>Task A-3 Performs routine work practices</b> <b>28%</b>	<b>A-3.01 Uses documentation and reference materials</b>	<b>A-3.02 Maintains fluids and lubricants</b>	<b>A-3.03 Services hoses, tubing and fittings</b>
	<b>A-3.04 Services filters</b>	<b>A-3.05 Services bearings and seals</b>	<b>A-3.06 Uses fasteners and sealing devices</b>
<b>Task A-4 Uses communication and mentoring techniques</b> <b>12%</b>	<b>A-4.01 Uses communication techniques</b>	<b>A-4.02 Uses mentoring techniques</b>	

## B – Services, diagnoses and repairs engines and supporting systems

**15%**

Task B-5 Services, diagnoses and repairs base engines <b>15%</b>	B-5.01 Services base engines	B-5.02 Diagnoses base engines	B-5.03 Repairs base engines
Task B-6 Services, diagnoses and repairs lubrication systems <b>10%</b>	B-6.01 Services lubrication systems	B-6.02 Diagnoses lubrication systems	B-6.03 Repairs lubrication systems
Task B-7 Services, diagnoses and repairs intake systems <b>13%</b>	B-7.01 Services intake systems	B-7.02 Diagnoses intake systems	B-7.03 Repairs intake systems
Task B-8 Services, diagnoses and repairs exhaust systems <b>14%</b>	B-8.01 Services exhaust systems	B-8.02 Diagnoses exhaust systems	B-8.03 Repairs exhaust systems
Task B-9 Services, diagnoses and repairs engine management systems <b>17%</b>	B-9.01 Services engine management systems	B-9.02 Diagnoses engine management systems	B-9.03 Repairs engine management systems
Task B-10 Services, diagnoses and repairs fuel delivery systems <b>13%</b>	B-10.01 Services fuel delivery systems	B-10.02 Diagnoses fuel delivery systems	B-10.03 Repairs fuel delivery systems
Task B-11 Services, diagnoses and repairs engine retarder systems <b>3%</b>	B-11.01 Services engine retarder systems	B-11.02 Diagnoses engine retarder systems	B-11.03 Repairs engine retarder systems
Task B-12 Services, diagnoses and repairs cooling systems <b>10%</b>	B-12.01 Services cooling systems	B-12.02 Diagnoses cooling systems	B-12.03 Repairs cooling systems

## C – Services, diagnoses and repairs air systems and brake systems

**13%**

<b>Task C-13 Services, diagnoses and repairs air systems</b> <b>51%</b>	<b>C-13.01 Services air systems</b>	<b>C-13.02 Diagnoses air systems</b>	<b>C-13.03 Repairs air systems</b>
<b>Task C-14 Services, diagnoses and repairs brake systems</b> <b>49%</b>	<b>C-14.01 Services brake systems</b>	<b>C-14.02 Diagnoses brake systems</b>	<b>C-14.03 Repairs brake systems</b>

## D – Services, diagnoses and repairs electrical and electronic systems

**16%**

<b>Task D-15 Services, diagnoses and repairs battery systems</b> <b>13%</b>	<b>D-15.01 Services battery systems</b>	<b>D-15.02 Diagnoses battery systems</b>	<b>D-15.03 Repairs battery systems</b>
<b>Task D-16 Services, diagnoses and repairs charging systems</b> <b>19%</b>	<b>D-16.01 Services charging systems</b>	<b>D-16.02 Diagnoses charging systems</b>	<b>D-16.03 Repairs charging systems</b>
<b>Task D-17 Services, diagnoses and repairs spark ignition systems</b> <b>8%</b>	<b>D-17.01 Services spark ignition systems</b>	<b>D-17.02 Diagnoses spark ignition systems</b>	<b>D-17.03 Repairs spark ignition systems</b>
<b>Task D-18 Services, diagnoses and repairs starting systems</b> <b>19%</b>	<b>D-18.01 Services starting systems</b>	<b>D-18.02 Diagnoses starting systems</b>	<b>D-18.03 Repairs starting systems</b>
<b>Task D-19 Services, diagnoses and repairs electrical components and accessories</b> <b>21%</b>	<b>D-19.01 Services electrical components and accessories</b>	<b>D-19.02 Diagnoses electrical components and accessories</b>	<b>D-19.03 Repairs electrical components and accessories</b>
<b>Task D-20 Services, diagnoses and repairs vehicle management systems and electronic components</b> <b>20%</b>	<b>D-20.01 Services vehicle management systems and electronic components</b>	<b>D-20.02 Diagnoses vehicle management systems and electronic components</b>	<b>D-20.03 Repairs vehicle management systems and electronic components</b>

## E – Services, diagnoses and repairs drive trains

**12%**

<b>Task E-21 Services, diagnoses and repairs clutches</b> <b>13%</b>	<b>E-21.01 Services clutches</b>	<b>E-21.02 Diagnoses clutches</b>	<b>E-21.03 Repairs clutches</b>
<b>Task E-22 Services, diagnoses and repairs manual transmissions and transfer cases</b> <b>17%</b>	<b>E-22.01 Services manual transmissions and transfer cases</b>	<b>E-22.02 Diagnoses manual transmissions and transfer cases</b>	<b>E-22.03 Repairs manual transmissions and transfer cases</b>
<b>Task E-23 Services, diagnoses and repairs automatic transmissions</b> <b>15%</b>	<b>E-23.01 Services automatic transmissions</b>	<b>E-23.02 Diagnoses automatic transmissions</b>	<b>E-23.03 Repairs automatic transmissions</b>
<b>Task E-24 Services, diagnoses and repairs automated transmissions</b> <b>20%</b>	<b>E-24.01 Services automated transmissions</b>	<b>E-24.02 Diagnoses automated transmissions</b>	<b>E-24.03 Repairs automated transmissions</b>
<b>Task E-25 Services, diagnoses and repairs driveline systems</b> <b>12%</b>	<b>E-25.01 Services driveline systems</b>	<b>E-25.02 Diagnoses driveline systems</b>	<b>E-25.03 Repairs driveline systems</b>
<b>Task E-26 Services, diagnoses and repairs drive axle assemblies</b> <b>16%</b>	<b>E-26.01 Services drive axle assemblies</b>	<b>E-26.02 Diagnoses drive axle assemblies</b>	<b>E-26.03 Repairs drive axle assemblies</b>
<b>Task E-27 Services, diagnoses and repairs drive train retarders</b> <b>7%</b>	<b>E-27.01 Services drive train retarders</b>	<b>E-27.02 Diagnoses drive train retarders</b>	<b>E-27.03 Repairs drive train retarders</b>

## F – Services, diagnoses and repairs steering, chassis/frames, suspensions, tires, wheels and hubs

**13%**

<b>Task F-28 Services, diagnoses and repairs steering systems</b> <b>26%</b>	<b>F-28.01 Services steering systems</b>	<b>F-28.02 Diagnoses steering systems</b>	<b>F-28.03 Repairs steering systems</b>
<b>Task F-29 Services, diagnoses and repairs chassis/frames</b> <b>14%</b>	<b>F-29.01 Services chassis/frames</b>	<b>F-29.02 Diagnoses chassis/frames</b>	<b>F-29.03 Repairs chassis/frames</b>
<b>Task F-30 Services, diagnoses and repairs suspensions</b> <b>23%</b>	<b>F-30.01 Services suspensions</b>	<b>F-30.02 Diagnoses suspensions</b>	<b>F-30.03 Repairs suspensions</b>
<b>Task F-31 Services, diagnoses and repairs hitches and couplers</b> <b>15%</b>	<b>F-31.01 Services hitches and couplers</b>	<b>F-31.02 Diagnoses hitches and couplers</b>	<b>F-31.03 Repairs hitches and couplers</b>
<b>Task F-32 Services, diagnoses and repairs tires, wheels and hubs</b> <b>22%</b>	<b>F-32.01 Services tires, wheels and hubs</b>	<b>F-32.02 Diagnoses tires, wheels and hubs</b>	<b>F-32.03 Repairs tires, wheels and hubs</b>

## G – Services, diagnoses and repairs cabs

**4%**

<b>Task G-33 Services, diagnoses and repairs interior cab components</b> <b>56%</b>	<b>G-33.01 Services interior cab components</b>	<b>G-33.02 Diagnoses interior cab components</b>	<b>G-33.03 Repairs interior cab components</b>
<b>Task G-34 Services, diagnoses and repairs exterior cab components</b> <b>44%</b>	<b>G-34.01 Services exterior cab components</b>	<b>G-34.02 Diagnoses exterior cab components</b>	<b>G-34.03 Repairs exterior cab components</b>

## H – Services, diagnoses and repairs trailers

6%

<b>Task H-35 Services, diagnoses and repairs trailer components and accessories</b> <b>59%</b>	<b>H-35.01 Services trailer components and accessories</b>	<b>H-35.02 Diagnoses trailer components and accessories</b>	<b>H-35.03 Repairs trailer components and accessories</b>
<b>Task H-36 Services, diagnoses and repairs heating and refrigeration systems</b> <b>41%</b>	<b>H-36.01 Services heating and refrigeration systems</b>	<b>H-36.02 Diagnoses heating and refrigeration systems</b>	<b>H-36.03 Repairs heating and refrigeration systems</b>

## I – Services, diagnoses and repairs climate control systems

6%

<b>Task I-37 Services, diagnoses and repairs heating and ventilation systems</b> <b>46%</b>	<b>I-37.01 Services heating and ventilation systems</b>	<b>I-37.02 Diagnoses heating and ventilation systems</b>	<b>I-37.03 Repairs heating and ventilation systems</b>
<b>Task I-38 Services, diagnoses and repairs air conditioning systems</b> <b>54%</b>	<b>I-38.01 Services air conditioning systems</b>	<b>I-38.02 Diagnoses air conditioning systems</b>	<b>I-38.03 Repairs air conditioning systems</b>

## J – Services, diagnoses and repairs hydraulic systems

6%

<b>Task J-39 Services, diagnoses and repairs hydraulic systems</b> <b>100%</b>	<b>J-39.01 Services hydraulic systems</b>	<b>J-39.02 Diagnoses hydraulic systems</b>	<b>J-39.03 Repairs hydraulic systems</b>
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## **K – Services, diagnoses and repairs hybrid and electric vehicles (EV)**

**3%**

<b>Task K-40 Services, diagnoses and repairs hybrid vehicles</b> <b>51%</b>	<b>K-40.01 Services hybrid vehicles</b>	<b>K-40.02 Diagnoses hybrid vehicles</b>	<b>K-40.03 Repairs hybrid vehicles</b>
<b>Task K-41 Services, diagnoses and repairs electric vehicles (EV)</b> <b>49%</b>	<b>K-41.01 Services electric vehicles (EV)</b>	<b>K-41.02 Diagnoses electric vehicles (EV)</b>	<b>K-41.03 Repairs electric vehicles (EV)</b>

# Harmonization of Apprenticeship Training

Provincial and territorial apprenticeship authorities are each responsible for their respective apprenticeship programs. In the spirit of continual improvement, and to facilitate mobility among apprentices in Canada, participating authorities have agreed to work towards harmonizing certain aspects of their programs where possible. After consulting with their stakeholders in the trade, they have reached consensus on the following elements. Note that implementation of these elements may vary from jurisdiction to jurisdiction, depending on their own circumstances. For more information on the implementation in any province and territory, please contact that jurisdiction's apprenticeship authority.

## 1. Trade name

The official Red Seal name for this trade is Truck and Transport Mechanic.

## 2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for this trade is 4 (four).

## 3. Total Training Hours during Apprenticeship Training

The total hours of training, including both on-the-job and in-school training for this trade is 7200.

## 4. Sequencing Topics and Related Sub-tasks

The topic titles in the table below are placed in a column for each apprenticeship level for technical training. Each topic is accompanied by the sub-tasks and their reference number. The topics in the grey shaded cells represent those that are covered "in context" with other training in the subsequent years.

Level 1	Level 2	Level 3	Level 4
	Context	Context	Context
	Routine Trade Activities	Routine Trade Activities	Routine Trade Activities
	Hybrid Vehicles	Hybrid Vehicles	
	Electric Vehicles (EV)	Electric Vehicles (EV)	
<b>Safety-Related Functions</b> <b>1.01 Maintains safe work environment</b> <b>1.02 Uses personal protective equipment (PPE) and safety equipment</b> <b>1.03 Implements specific safety protocols for hybrid and electric vehicles (EV)</b>			

Level 1	Level 2	Level 3	Level 4
<b>Tools and Equipment</b> 2.01 Uses hand, power, measuring, testing, and diagnostic tools 2.02 Uses shop equipment 2.03 Uses hoisting, lifting and staging equipment 2.04 Uses welding and cutting equipment 2.05 Uses electronic devices and systems for diagnostics and programming			
<b>Routine Trade Activities</b> 3.01 Uses documentation and reference materials 3.02 Maintains fluids, lubricants, and coolants 3.03 Services hoses, tubing, and fittings 3.04 Services filters 3.05 Services bearings, bushing and seals 3.06 Uses fasteners, sealing devices, adhesives and gaskets			
<b>Communication Techniques</b> 4.01 Uses communication techniques			<b>Mentoring Techniques</b> 4.02 Uses mentoring techniques
	<b>Base Engine</b> 5.01 Services base engine 5.02 Diagnoses base engine 5.03 Repairs base engine	<b>Base Engine</b> 5.01 Services base engine 5.02 Diagnoses base engine 5.03 Repairs base engine	
	<b>Lubrication System</b> 6.01 Services lubrication systems 6.02 Diagnoses lubrication systems 6.03 Repairs lubrication systems	<b>Lubrication System</b> 6.01 Services lubrication systems 6.02 Diagnoses lubrication systems 6.03 Repairs lubrication systems	
	<b>Intake Systems</b> 7.01 Services intake-systems 7.02 Diagnoses intake systems 7.03 Repairs intake systems	<b>Intake Systems</b> 7.01 Services intake systems 7.02 Diagnoses intake systems 7.03 Repairs intake systems	
	<b>Exhaust Systems</b> 8.01 Services exhaust systems 8.02 Diagnoses exhaust systems 8.03 Repairs exhaust systems	<b>Exhaust Systems</b> 8.01 Services exhaust systems 8.02 Diagnoses exhaust systems 8.03 Repairs exhaust systems	
	<b>Engine Management Systems</b> 9.01 Services engine management systems 9.02 Diagnoses engine management systems 9.03 Repairs engine management systems	<b>Engine Management Systems</b> 9.01 Services engine management systems 9.02 Diagnoses engine management systems 9.03 Repairs engine management systems	

Level 1	Level 2	Level 3	Level 4
	<b>Fuel Delivery System</b> 10.01 Services fuel delivery systems 10.02 Diagnoses fuel delivery systems 10.03 Repairs fuel delivery systems	<b>Fuel Delivery System</b> 10.01 Services fuel delivery systems 10.02 Diagnoses fuel delivery systems 10.03 Repairs fuel delivery systems	
	<b>Engine Retarder Systems</b> 11.01 Services engine retarder systems 11.02 Diagnoses engine retarder systems 11.03 Repairs engine retarder systems	<b>Engine Retarder Systems</b> 11.01 Services engine retarder systems 11.02 Diagnoses engine retarder systems 11.03 Repairs engine retarder systems	
	<b>Cooling System</b> 12.01 Services cooling system 12.02 Diagnoses cooling system 12.03 Repairs cooling system	<b>Cooling System</b> 12.01 Services cooling system 12.02 Diagnoses cooling system 12.03 Repairs cooling system	
<b>Air Systems</b> 13.01 Services air systems 13.02 Diagnoses air systems 13.03 Repairs air systems			<b>Air Systems</b> 13.01 Services air systems 13.02 Diagnoses air systems 13.03 Repairs air systems
<b>Brake Systems</b> 14.01 Services brake systems 14.02 Diagnoses brake systems 14.03 Repairs brake systems			<b>Brake Systems</b> 14.01 Services brake systems 14.02 Diagnoses brake systems 14.03 Repairs brake systems
<b>Battery systems</b> 15.01 Services battery systems 15.02 Diagnoses battery systems 15.03 Repairs battery systems			
<b>Charging Systems</b> 16.01 Services charging systems 16.02 Diagnoses charging systems 16.03 Repairs charging systems	<b>Charging Systems</b> 16.01 Services charging systems 16.02 Diagnoses charging systems 16.03 Repairs charging systems		
		<b>Spark Ignition Systems</b> 17.01 Services spark ignition systems 17.02 Diagnoses spark ignition systems 17.03 Repairs spark ignition systems	
<b>Starting Systems</b> 18.01 Services starting systems 18.02 Diagnoses starting systems 18.03 Repairs starting systems	<b>Starting Systems</b> 18.01 Services starting systems 18.02 Diagnoses starting systems 18.03 Repairs starting systems		

Level 1	Level 2	Level 3	Level 4
<b>Electrical Components and Accessories</b> 19.01 Services electrical components and accessories 19.02 Diagnoses electrical components and accessories 19.03 Repairs electrical components and accessories	<b>Electrical Components and Accessories</b> 19.01 Services electrical components and accessories 19.02 Diagnoses electrical components and accessories 19.03 Repairs electrical components and accessories		
	<b>Vehicle Management Systems and Electronic Components</b> 20.01 Services vehicle management systems and electronic components 20.02 Diagnoses vehicle management systems and electronic components 20.03 Repairs vehicle management systems and electronic components	<b>Vehicle Management Systems and Electronic Components</b> 20.01 Services vehicle management systems and electronic components 20.02 Diagnoses vehicle management systems and electronic components 20.03 Repairs vehicle management systems and electronic components	
	<b>Clutches</b> 21.01 Services clutches 21.02 Diagnoses clutches 21.03 Repairs clutches	<b>Clutches</b> 21.01 Services clutches 21.02 Diagnoses clutches 21.03 Repairs clutches	
	<b>Manual Transmission and Transfer Cases</b> 22.01 Services manual transmission and transfer cases 22.02 Diagnoses manual transmission and transfer cases 22.03 Repairs manual transmission and transfer cases	<b>Manual Transmission and Transfer Cases</b> 22.01 Services manual transmission and transfer cases 22.02 Diagnoses manual transmission and transfer cases 22.03 Repairs manual transmission and transfer cases	
	<b>Automatic Transmissions</b> 23.01 Services automatic transmissions 23.02 Diagnoses automatic transmissions 23.03 Repairs automatic transmissions	<b>Automatic Transmissions</b> 23.01 Services automatic transmissions 23.02 Diagnoses automatic transmissions 23.03 Repairs automatic transmissions	
	<b>Automated Transmissions</b> 24.01 Services automated transmissions 24.02 Diagnoses automated transmissions 24.03 Repairs automated transmissions	<b>Automated Transmissions</b> 24.01 Services automated transmissions 24.02 Diagnoses automated transmissions 24.03 Repairs automated transmissions	
	<b>Driveline Systems</b> 25.01 Services driveline systems 25.02 Diagnoses driveline systems 25.03 Repairs driveline systems	<b>Driveline Systems</b> 25.01 Services driveline systems 25.02 Diagnoses driveline systems 25.03 Repairs driveline systems	

Level 1	Level 2	Level 3	Level 4
	<b>Drive Axle Assemblies</b> 26.01 Services drive axle assemblies 26.02 Diagnoses drive axle assemblies 26.03 Repairs drive axle assemblies	<b>Drive Axle Assemblies</b> 26.02 Diagnoses drive axle assemblies 26.03 Repairs drive axle assemblies	
	<b>Drive Train Retarders</b> 27.01 Services drive train retarders 27.02 Diagnoses drive train retarders 27.03 Repairs drive train retarders	<b>Drive Train Retarders</b> 27.01 Services drive train retarders 27.02 Diagnoses drive train retarders 27.03 Repairs drive train retarders	
<b>Steering Systems</b> 28.01 Services steering systems 28.02 Diagnoses steering systems 28.03 Repairs steering systems			<b>Steering Systems</b> 28.01 Services steering systems 28.02 Diagnoses steering systems 28.03 Repairs steering systems
<b>Chassis/ Frames</b> 29.01 Services, chassis/frames 29.02 Diagnoses chassis/frames 29.03 Repairs chassis/frames			<b>Chassis/ Frames</b> 29.01 Services, chassis/frames 29.02 Diagnoses chassis/frames 29.03 Repairs chassis/frames
<b>Suspensions</b> 30.01 Services suspensions 30.02 Diagnoses suspensions 30.03 Repairs suspensions			<b>Suspensions</b> 30.01 Services suspensions 30.02 Diagnoses suspensions 30.03 Repairs suspensions
<b>Hitches and Couplers</b> 31.01 Services hitches and couplers 31.02 Diagnoses hitches and couplers 31.03 Repairs hitches and couplers			<b>Hitches and Couplers</b> 31.01 Services hitches and couplers 31.02 Diagnoses hitches and couplers 31.03 Repairs hitches and couplers
<b>Tires, Wheels and Hubs</b> 32.01 Services tires wheels and hubs 32.02 Diagnoses tires, wheels and hubs 32.03 Repairs tires, wheels and hubs			<b>Tires, Wheels and Hubs</b> 32.01 Services tires wheels and hubs 32.02 Diagnoses tires, wheels and hubs 32.03 Repairs tires, wheels and hubs
			<b>Interior Cab Components</b> 33.01 Services interior cab components 33.02 Diagnoses interior cab components 33.03 Repairs interior cab components.

Level 1	Level 2	Level 3	Level 4
<b>Exterior Cab Components</b> 34.01 Services exterior cab components 34.02 Diagnoses exterior cab components 34.03 Repairs exterior cab components			<b>Trailer Components and Accessories</b> 35.01 Services trailer components and accessories 35.02 Diagnoses trailer components and accessories 35.03 Repairs trailer components and accessories
			<b>Heating and Refrigeration Systems</b> 36.01 Services heating and refrigeration systems 36.02 Diagnoses heating and refrigeration systems 36.03 Repairs heating and refrigeration systems
<b>Heating and Ventilation Systems</b> 37.01 Services heating and ventilation systems 37.02 Diagnoses heating and ventilation systems 37.03 Repairs, heating and ventilation systems	<b>Heating and Ventilation Systems</b> 37.01 Services heating and ventilation systems 37.02 Diagnoses heating and ventilation systems 37.03 Repairs, heating and ventilation systems		
<b>Air Conditioning Systems</b> 38.01 Services air conditioning systems 38.02 Diagnoses air conditioning systems 38.03 Repairs air conditioning systems	<b>Air Conditioning Systems</b> 38.01 Services air conditioning systems 38.02 Diagnoses air conditioning systems 38.03 Repairs air conditioning systems		
<b>Hydraulic Systems</b> 39.01 Services hydraulic systems 39.02 Diagnoses hydraulic systems 39.03 Repairs hydraulic systems			<b>Hydraulic Systems</b> 39.01 Services hydraulic systems 39.02 Diagnoses hydraulic systems 39.03 Repairs hydraulic systems
<b>Hybrid Vehicles</b> 40.01 Services hybrid vehicles 40.02 Diagnoses hybrid vehicle 40.03 Repairs hybrid vehicles			<b>Hybrid Vehicles</b> 40.01 Services hybrid vehicles 40.02 Diagnoses hybrid vehicle 40.03 Repairs hybrid vehicles
<b>Electric Vehicles (EV)</b> 41.01 Services electric vehicles (EV) 41.02 Diagnoses electric vehicles (EV) 41.03 Repairs electric vehicles (EV)			<b>Electric Vehicles (EV)</b> 41.01 Services electric vehicles (EV) 41.02 Diagnoses electric vehicles (EV) 41.03 Repairs electric vehicles (EV)

# Major Work Activity A

## Performs common occupational skills

### Task A-1 Performs safety-related functions

#### Task Descriptor

Truck and transport mechanics create and maintain a safe work environment to ensure safety of equipment and personnel. They must wear personal protective equipment (PPE), use safety equipment, and follow manufacturers' service information when performing certain tasks.

Truck and transport mechanics are increasingly working on electric motors, inverters, converters, high-voltage batteries and associated support systems in hybrid and electric vehicles (EV). Safety is of paramount importance due to the risk of electrocution when working with high voltages.

#### A-1.01 Maintains safe work environment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-1.01.01P	assess work area	field-level risk assessment is completed
A-1.01.02P	identify potential <b>hazards</b>	potential <b>hazards</b> in hydraulic, pneumatic, electrical, fuel and air conditioning systems are identified by performing sensory inspection of vehicles and surrounding area
A-1.01.03P	handle, store, recycle and dispose of <b>hazardous materials</b>	<b>hazardous materials</b> are handled, stored, recycled and disposed of according to company policies and procedures, and <b>jurisdictional safety regulations</b>
A-1.01.04P	perform <b>housekeeping duties</b>	<b>housekeeping duties</b> are performed according to company policies and procedures
A-1.01.05P	use ventilation equipment to extract and contain fumes, smoke and dust	ventilation equipment is used according to safe work procedures to extract and contain fumes, smoke and dust



A-1.01.06P	identify safe lifting locations or points	safe lifting locations or points are identified according to <b>manufacturers' service information</b>
A-1.01.07P	identify location of <b>workplace safety equipment</b> and emergency phone numbers	location of <b>workplace safety equipment</b> and emergency phone numbers are identified

## Range of Variables

**hazards** include: air lines, extension cords, broken equipment, fluids and gases under high pressure, ceiling heights, overhead wires, uneven surfaces, pinch/crush points, heavy tools and parts, energized equipment

**hazardous materials** include: chemicals, refrigerants, high-pressure gases, fluids, fuels, lubricants

**jurisdictional safety regulations** include: Occupational Health and Safety (OH&S), WHMIS

**housekeeping duties** include: sweeping, discarding defective components, keeping area clear of obstacles

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**workplace safety equipment** includes: safety stations, first aid kits, eyewash stations, fire extinguishing equipment, spill kits, PPE, automated external defibrillator (AED)

Knowledge		
	Learning Outcomes	Learning Objectives
A-1.01.01L	demonstrate knowledge of safe work practices	describe safe work practices to maintain a safe work environment
		describe procedures to handle, store, recycle and dispose of <b>hazardous materials</b>
		identify <b>workplace safety equipment</b> , and describe their characteristics and applications
A-1.01.02L	demonstrate knowledge of certification and regulatory requirements pertaining to safety	identify and describe <b>jurisdictional safety regulations</b> to maintain safe work environment
		identify <b>components of</b> Workplace Hazardous Materials Information System ( <b>WHMIS</b> ) and associated certifications
		identify and describe jurisdictional requirements for handling, recycling and disposing of <b>hazardous materials</b>

## Range of Variables

**hazardous materials** include: chemicals, refrigerants, high-pressure gases, fluids, fuels, lubricants

**workplace safety equipment** includes: safety stations, first aid kits, eyewash stations, fire extinguishing equipment, spill kits, PPE, automated external defibrillator (AED)

**jurisdictional safety regulations** include: Occupational Health and Safety (OH&S), WHMIS

**components of WHMIS** include: safety data sheets (SDS), labels, training, muster points

## A-1.02 Uses personal protective equipment (PPE) and safety equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
A-1.02.01P	select and use <b>PPE</b> and <b>safety equipment</b>	<b>PPE</b> and <b>safety equipment</b> are selected, fit and used according to <b>work conditions and requirements</b> , company policies and <b>manufacturers' service information</b>
A-1.02.02P	store and maintain <b>PPE</b> and <b>safety equipment</b>	<b>PPE</b> and <b>safety equipment</b> are stored and maintained according to company policies and <b>manufacturers' service information</b>
A-1.02.03P	repair or replace, and report worn damaged or defective <b>PPE</b> and <b>safety equipment</b>	worn, damaged or defective <b>PPE</b> and <b>safety equipment</b> are repaired or replaced, and reported according to company policies and <b>jurisdictional safety regulations</b>

### Range of Variables

**PPE** includes: hard hats, gloves, respirators, safety glasses, hearing protection, safety boots, protective clothing, face shields, high-visibility clothing

**safety equipment** includes: fall arrest, fall protection, guarding, shielding, jack/support stands, wheel chocks, lock-out, tag-out

**work conditions and requirements** include: wearing rubber gloves when handling hazardous or carcinogenic materials, wearing eye and hearing protection when hammering and grinding metals, wearing masks and breathing protection when working around hazardous airborne and liquid substances

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**jurisdictional safety regulations** include: OH&S, WHMIS

### Knowledge

	Learning Outcomes	Learning Objectives
A-1.02.01L	demonstrate knowledge of <b>PPE</b> and <b>safety equipment</b> , their characteristics, applications and procedures for use	identify types of <b>PPE</b> and <b>safety equipment</b> , and describe their characteristics, applications and procedures for use
		describe handling, storage and maintenance of <b>PPE</b> and <b>safety equipment</b>

A-1.02.02L	demonstrate knowledge of training, certification and regulatory requirements for <b>PPE</b> and <b>safety equipment</b>	identify training and certification requirements pertaining to <b>PPE</b> and <b>safety equipment</b>
		identify safety manuals, <b>standards and regulations</b> and <b>jurisdictional safety regulations</b> pertaining to <b>PPE</b> and <b>safety equipment</b>

## Range of Variables

**PPE** includes: hard hats, gloves, respirators, safety glasses, hearing protection, safety boots, protective clothing, face shields, high-visibility clothing

**safety equipment** includes: fall arrest, fall protection, guarding, shielding, jack/support stands, wheel chocks, lock-out, tag-out

**standards and regulations** include: Canadian Standards Association (CSA), OH&S, site specific (company or client)

**jurisdictional safety regulations** include: OH&S, WHMIS

## A-1.03 Implements specific safety protocols for hybrid and electric vehicles (EV)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-1.03.01P	select and use <b>PPE and safety equipment specific to hybrid and EV systems</b>	<b>PPE and safety equipment specific to hybrid and EV systems</b> is selected and used according to <b>standards and regulations</b> , and <b>manufacturers' service information</b>
A-1.03.02P	select and use tools and equipment required to complete safety preparation	tools and equipment required to complete safety preparation are selected and used according to <b>standards and regulations</b> , and <b>manufacturers' service information</b>
A-1.03.03P	recognize <b>safety hazards specific to working on hybrid vehicles and EVs</b>	<b>safety hazards specific to working on hybrid vehicles and EVs</b> are identified
A-1.03.04P	ensure that <b>safety protocols for hybrid and EV systems</b> have been implemented	<b>safety protocols for hybrid and EV systems</b> have been implemented according to <b>standards and regulations</b> , and <b>manufacturers' service information</b>

## Range of Variables

**PPE and safety equipment specific to hybrid and EV systems** include: insulated gloves, pylons, high-voltage specific tools, safety hook, lock-out, tag-out, arc flash suits, helmets

**standards and regulations** include: CSA (e.g., z462), jurisdictional regulations

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**safety hazards specific to working on hybrid vehicles and EVs** include: electrocution, burns, arc flash

**safety protocols for hybrid and EV systems** include: safe work procedures for high voltage, manufacturers' safety procedures, maintenance facility requirements

Knowledge		
	Learning Outcomes	Learning Objectives
A-1.03.01L	demonstrate knowledge of <b>PPE and safety equipment specific to hybrid and EV systems</b> , their characteristics, applications and procedures for use	identify types of <b>PPE and safety equipment specific to hybrid and EV systems</b> , and describe their characteristics, applications and procedures for use
A-1.03.02L	demonstrate knowledge of <b>safety protocols for hybrid and EV systems</b>	identify <b>safety protocols for hybrid and EV systems</b>  identify <b>safety hazards specific to working on hybrid vehicles and EVs</b> and safe work practices
A-1.03.03L	demonstrate knowledge of regulatory requirements pertaining to hybrid and EV systems	identify and interpret <b>standards and regulations</b> pertaining to hybrid and EV systems

## Range of Variables

**PPE and safety equipment specific to hybrid and EV systems** include: insulated gloves, pylons, high-voltage specific tools, safety hook, lock-out, tag-out, arc flash suits, helmets

**safety protocols for hybrid and EV systems** include: safe work procedures for high voltage, manufacturers' safety procedures, maintenance facility requirements

**safety hazards specific to working on hybrid vehicles and EVs** include: electrocution, burns, arc flash

**standards and regulations** include: CSA (e.g., z462), jurisdictional regulations

## Task A-2 Uses and maintains tools and equipment

### Task Descriptor

Truck and transport mechanics use tools and equipment to perform all tasks in their trade in a safe and efficient manner. They maintain these tools and equipment to ensure longevity and safe operation of tooling.

#### A-2.01 Uses hand, power, measuring, testing, and diagnostic tools

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-2.01.01P	select and use hand, power, measuring, testing and diagnostic tools	hand, power, measuring, testing and diagnostic tools are selected and used according to task, company policies and procedures, and <b>manufacturers' service information</b>
A-2.01.02P	inspect hand, power, measuring, testing and diagnostic tools	hand, power, measuring, testing and diagnostic tools are inspected for wear, damage and defects according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.01.03P	clean hand, power, measuring, testing and diagnostic tools	hand, power, measuring, testing and diagnostic tools are cleaned according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.01.04P	lubricate power tools	power tools are lubricated according to <b>manufacturers' service information</b>
A-2.01.05P	calibrate measuring tools	measuring tools are calibrated according to <b>manufacturers' service information</b>
A-2.01.06P	sharpen tools	tools are sharpened according to company policies and procedures, and type of material being used
A-2.01.07P	store hand, power, measuring, testing and diagnostic tools	hand, power, measuring, testing and diagnostic tools are stored according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.01.08P	repair or replace worn, damaged and faulty hand, power, measuring, testing and diagnostic tools	worn, damaged and faulty hand, power, measuring, testing and diagnostic tools are repaired or replaced according to company policies and procedures

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

Knowledge		
Learning Outcomes		Learning Objectives
A-2.01.01L	demonstrate knowledge of hand, power, measuring, testing and diagnostic tools, their characteristics, applications, maintenance and procedures for use	identify types of hand, power, measuring, testing and diagnostic tools, and describe their characteristics, applications and procedures for use
		identify hazards and describe safe work practices pertaining to hand, power, measuring, testing and diagnostic tools
		describe procedures to inspect hand, power, measuring, testing and diagnostic tools
		describe procedures to lubricate and clean tools
		describe procedures to sharpen tools
		describe procedures to take worn, damaged and faulty hand, power, measuring, testing and diagnostic tools out of service for repair or replacement
		describe procedures to destroy and dispose of damaged and defective hand, power, measuring, testing and diagnostic tools

## A-2.02 Uses shop equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
Performance Criteria		Evidence of Attainment
A-2.02.01P	select and use shop equipment	shop equipment is selected and used according to task, company policies and procedures, and <b>manufacturers' service information</b>
A-2.02.02P	recognize and interpret tags on shop equipment identifying load limits	tags on shop equipment identifying load limits are recognized and interpreted

A-2.02.03P	visually inspect shop equipment for inspection tags, wear, damage and defects and remove from service	shop equipment is visually inspected for inspection tags, wear, damage and defects and are removed from service and reported according to company policies and procedures
A-2.02.04P	lubricate and clean shop equipment	shop equipment is lubricated and cleaned according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.02.05P	maintain solvent washers and biological parts washers	solvent washers and biological parts washers are maintained according to <b>manufacturers' service information</b>
A-2.02.06P	store shop equipment	shop equipment is stored according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.02.07P	identify potential <b>hazards</b>	potential <b>hazards</b> are identified
A-2.02.08P	verify certification dates	certification dates are verified to ensure they are current according to jurisdictional regulations

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: ceiling heights, overhead wires, uneven surfaces, rotating equipment, exhaust fumes, pinch/crush points, fire, explosions, flying debris, tripping

Knowledge		
	Learning Outcomes	Learning Objectives
A-2.02.01L	demonstrate knowledge of shop equipment, their characteristics, applications, maintenance and procedures for use	identify types of shop equipment and describe their characteristics and applications
		identify <b>hazards</b> and describe safe work practices pertaining to shop equipment
		identify load limitations of shop equipment
		describe procedures to inspect shop equipment
		describe procedures to lubricate and clean shop equipment
		describe procedures to record and report damaged and defective shop equipment
		describe procedures to store shop equipment
		explain inspection certification dates on shop equipment

A-2.02.02L	demonstrate knowledge of training and certification requirements to use shop equipment	identify training and certification requirements to use shop equipment
A-2.02.03L	demonstrate knowledge of regulatory requirements to maintain shop equipment	identify and interpret standards and jurisdictional regulations to maintain shop equipment

## Range of Variables

**hazards** include: ceiling heights, overhead wires, uneven surfaces, rotating equipment, exhaust fumes, pinch/crush points, fire, explosions, flying debris, tripping

## A-2.03 Uses hoisting, lifting and staging equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
A-2.03.01P	select and operate hoisting, lifting and staging equipment	hoisting, lifting and staging equipment are selected and operated according to task, equipment limitations, company policies and procedures, and <b>manufacturers' service information</b>
A-2.03.02P	inspect hoisting, lifting and staging equipment for wear, damage, leaks and defects	hoisting, lifting and staging equipment are inspected for wear, damage, leaks and defects according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.03.03P	repair, replace, dispose of and report worn, damaged and defective components on hoisting, lifting and staging equipment	worn, damaged and defective components on hoisting, lifting and staging equipment are repaired, replaced or disposed of, and reported according to company policies and procedures
A-2.03.04P	store hoisting, lifting and staging equipment	hoisting, lifting and staging equipment are stored according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.03.05P	position and connect hoisting, lifting and staging equipment	hoisting, lifting and staging equipment are positioned and connected according to company policies and procedures, and <b>manufacturers' service information</b>



A-2.03.06P	secure hoisting, lifting and staging equipment	hoisting, lifting and staging equipment are secured to prevent movement according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.03.07P	identify potential <b>hazards</b> and implement measures to minimize risk	potential <b>hazards</b> are identified and measures are implemented to minimize risk

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: ceiling heights, overhead wires, uneven surfaces

Knowledge		
	Learning Outcomes	Learning Objectives
A-2.03.01L	demonstrate knowledge of hoisting, lifting and staging equipment, their components, characteristics, applications and maintenance	identify types of hoisting, lifting and staging equipment and their components, and describe their characteristics and applications
		describe procedures to inspect hoisting, lifting and staging equipment
		describe procedures to repair, replace and dispose of hoisting, lifting and staging equipment components
		describe procedures to store hoisting, lifting and staging equipment
		describe procedures to position and connect hoisting, lifting and staging equipment
		describe procedures to record and report damaged and defective hoisting, lifting and staging equipment
A-2.03.02L	demonstrate knowledge of procedures to operate hoisting, lifting and staging equipment	identify <b>factors</b> to consider when selecting hoisting, lifting and staging equipment
		identify <b>hazards</b> and describe <b>safe work practices</b> pertaining to hoisting, lifting and staging equipment
		describe procedures to operate hoisting, lifting and staging equipment
A-2.03.03L	demonstrate knowledge of training and certification requirements to operate hoisting, lifting and staging equipment	describe training and certification requirements to operate hoisting, lifting and staging equipment
A-2.03.04L	demonstrate knowledge of regulatory requirements to operate hoisting, lifting and staging equipment	locate, identify and interpret regulations to operate hoisting, lifting and staging equipment

## Range of Variables

**factors** include: load characteristics, environment, safety factors, anchor points, sling angles

**hazards** include: ceiling heights, overhead wires, uneven surfaces

**safe work practices** include: supervision of lifts, securing work area, communication

### A-2.04 Uses welding and cutting equipment

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-2.04.01P	select and use welding and cutting equipment	welding and cutting equipment are selected and used according to task, company policies and procedures, and <b>manufacturers' service information</b>
A-2.04.02P	clean welding and cutting tips	welding and cutting tips are cleaned according to <b>manufacturers' service information</b>
A-2.04.03P	transport welding and cutting equipment	welding and cutting equipment is transported according to jurisdictional regulations and Transportation of Dangerous Goods (TDG) Act
A-2.04.04P	inspect welding and cutting equipment for wear, damage, defects and potential <b>hazards</b>	welding and cutting equipment is inspected for wear, damage, defects and potential <b>hazards</b> , and findings are reported to supervisor/manager according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.04.05P	remove worn, damaged and defective welding and cutting equipment from service	worn, damaged and defective welding and cutting equipment is removed from service according to company policies and procedures
A-2.04.06P	determine when welding repairs should be completed by a certified welder	welding repairs to be completed by a certified welder are determined
A-2.04.07P	determine equipment and material selection	equipment and material selection are determined according to <b>materials</b> being worked on
A-2.04.08P	set up welding and cutting equipment	welding and cutting equipment is set up by adjusting controls for task being performed
A-2.04.09P	prepare vehicle for welding	vehicle is prepared for welding according to <b>manufacturers' service information</b> to prevent damage to vehicle and electronic components

A-2.04.10P	prepare work area for welding	work area is prepared for welding using <b>methods</b> according to task and company policies and procedures
A-2.04.11P	perform basic welding and cutting procedures	basic welding and cutting procedures are performed
A-2.04.12P	assess flow and penetration during welding	flow and penetration are assessed during welding according to sensory inspection
A-2.04.13P	shut down welding equipment	welding equipment is shut down according to company policies and procedures, and <b>manufacturers' service information</b>
A-2.04.14P	store and secure welding and cutting equipment	welding and cutting equipment is stored and secured according to company policies and procedures, <b>manufacturers' service information</b> and jurisdictional regulations

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: electrocution, fire, arc flash, metal poisoning, burns

**materials** include: aluminum, steel, stainless steel

**methods** include: removing combustibles, placing flash curtains, verifying ventilation

Knowledge		
	Learning Outcomes	Learning Objectives
A-2.04.01L	demonstrate knowledge of welding and cutting equipment, their characteristics, applications and maintenance	identify types of welding and cutting equipment, and describe their characteristics, applications and maintenance
		describe procedures to inspect welding and cutting equipment
		describe procedures to transport welding and cutting equipment
		describe procedures to store welding and cutting equipment
		identify <b>welding materials</b>
A-2.04.02L	demonstrate knowledge of procedures to use welding and cutting equipment	identify <b>hazards</b> and describe safe work practices pertaining to welding and cutting equipment
		describe procedures to use welding and cutting equipment
		identify welding and cutting principles and considerations
		identify welding and cutting basic procedures

A-2.04.03L	demonstrate knowledge of training and certification requirements to use welding and cutting equipment	identify training and certification requirements to use welding and cutting equipment
A-2.04.04L	demonstrate knowledge of regulatory requirements to transport and store welding and cutting equipment	identify and interpret standards and regulations to transport and store welding and cutting equipment

## Range of Variables

**welding materials** include: covered and coiled wire electrodes, shielding gases

**hazards** include: electrocution, fire, arc flash, metal poisoning, burns

## A-2.05 Uses electronic devices and systems for diagnostics and programming

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
A-2.05.01P	use <b>software applications</b>	<b>software applications</b> are used according to <b>manufacturers' service information</b>
A-2.05.02P	verify software version, download from manufacturer and upload to controllers	software version is verified, downloaded from manufacturer and uploaded to controllers
A-2.05.03P	select and use <b>electronic devices</b>	<b>electronic devices</b> are selected and used according to task and <b>manufacturers' service information</b>
A-2.05.04P	download and document reports from equipment controller and forward to original equipment manufacturer (OEM) or customer	reports from equipment controller are downloaded and documented and forwarded to OEM or customer
A-2.05.05P	monitor <b>data</b> and <b>parameters</b>	<b>data</b> and <b>parameters</b> are monitored for operational status according to <b>manufacturers' service information</b>
A-2.05.06P	adjust <b>parameters</b>	<b>parameters</b> are adjusted according to customer request and <b>manufacturers' service information</b>
A-2.05.07P	interpret diagnostic results and reports	diagnostic results and reports are interpreted to determine failure and required repair

## Range of Variables

**software applications** include: diagnostic and operating software, Internet-based technical support, remote monitoring systems

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**electronic devices** include: laptops, smart phones, tablets, communication interface adapters

**data** includes: temperatures, speeds, pressure, switch states, state of charge

**parameters** include: speeds, temperatures, pressures, anti-lock braking system (ABS), roll stability, software versions, power take-off (PTO) settings

Knowledge		
	Learning Outcomes	Learning Objectives
A-2.05.01L	demonstrate knowledge of using <b>electronic devices</b> for diagnostics and programming	identify types of <b>electronic devices</b> used in diagnostics and programming, and describe their characteristics, applications and procedures for use
		describe <b>software applications</b> used in diagnostics and programming
		describe manufacturers' programming and monitoring procedures
		describe elements of diagnostic results and reports
A-2.05.02L	demonstrate knowledge of training and certification available to use <b>electronic devices</b> for diagnostics and programming	describe training and certification available to use <b>electronic devices</b> for diagnostics and programming

## Range of Variables

**electronic devices** include: laptops, smart phones, tablets, communication interface adapters

**software applications** include: diagnostic and operating software, Internet-based technical support, remote monitoring systems

## Task A-3 Performs routine work practices

### Task Descriptor

Truck and transport mechanics reference different sources of documentation to diagnose, service and repair systems. Truck and transport mechanics must have knowledge of materials and hardware such as fasteners, bearings, sealing devices and their application.

#### A-3.01 Uses documentation and reference materials

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-3.01.01P	locate <b>information on vehicle</b>	<b>information on vehicle</b> is located
A-3.01.02P	locate and reference most recent <b>technical information</b>	most recent <b>technical information</b> is located and referenced for diagnostic, servicing and repair procedures
A-3.01.03P	interpret and apply <b>technical information</b> to situation	<b>technical information</b> is interpreted and applied to situation
A-3.01.04P	record <b>service history</b>	<b>service history</b> is recorded according to company policies and procedures, manufacturers' requirements and jurisdictional regulations
A-3.01.05P	create list of parts needed	list of parts needed is created according to repair required, and company policies and procedures
A-3.01.06P	match replacement part to original part	replacement part is matched to original part
A-3.01.07P	record <b>work-related information</b>	<b>work-related information</b> is recorded according to company policies and procedures, and manufacturers' requirements
A-3.01.08P	complete <b>safety-related documents</b>	<b>safety-related documents</b> are completed according to jurisdictional regulations, and company policies and procedures
A-3.01.09P	report completion of documentation to management	completion of documentation is reported to management according to company policies and procedures
A-3.01.10P	follow confidentiality guidelines	confidentiality guidelines are followed according to company policies and procedures

## Range of Variables

**information on vehicle** includes: vehicle identification numbers (VIN), component serial numbers, make and model of vehicle

**technical information** includes: shop service and parts manuals, troubleshooting trees, flow charts, schematics, technical drawings, specifications, test results, parameters, service bulletins

**service history** includes: motor vehicle inspections, warranty forms, preventive maintenance records, failure analysis using photographs

**work-related information** includes: technician hours worked, machine hours, VIN, parts used, task descriptions, mileage

**safety-related documents** include: accident reports, injury reports, safety inspection reports, workplace hazard reports

Knowledge		
	Learning Outcomes	Learning Objectives
A-3.01.01L	demonstrate knowledge of trade-related documentation, their characteristics and applications	identify types of trade-related documentation and describe their characteristics and applications
A-3.01.02L	demonstrate knowledge of procedures to use and complete trade-related documentation	describe procedures to use and complete trade-related documentation
A-3.01.03L	demonstrate knowledge of confidentiality guidelines	identify elements of confidentiality guidelines, and describe their characteristics and applications
A-3.01.04L	demonstrate knowledge of regulatory requirements pertaining to use and completion of trade-related documentation	identify and interpret regulations pertaining to use and completion of trade-related documentation

## A-3.02 Maintains fluids and lubricants

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-3.02.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
A-3.02.02P	identify safe handling procedures for <b>fluids</b> and <b>lubricants</b>	safe handling procedures for <b>fluids</b> and <b>lubricants</b> are identified according to WHMIS
A-3.02.03P	verify <b>fluid</b> levels	<b>fluid</b> levels are verified and adjusted according to <b>manufacturers' service information</b>

A-3.02.04P	identify and select types and grades of <b>fluids</b> and <b>lubricants</b>	types and grades of <b>fluids</b> and <b>lubricants</b> are identified and selected according to application, environmental conditions and <b>manufacturers' service information</b>
A-3.02.05P	identify and select types of coolants and additives	types of coolants and additives are identified and selected according to <b>manufacturers' service information</b>
A-3.02.06P	verify coolant has been mixed properly	coolant is verified using tools and equipment to ensure it has been mixed properly
A-3.02.07P	store, recycle and dispose of <b>fluids</b> and <b>lubricants</b>	<b>fluids</b> and <b>lubricants</b> are stored, recycled and disposed of according to jurisdictional regulations
A-3.02.08P	take <b>fluid samples</b>	<b>fluid samples</b> are taken according to instructions and <b>manufacturers' service information</b> from test lab
A-3.02.09P	interpret <b>fluid sample</b> results	<b>fluid sample</b> results are interpreted to indicate <b>issues</b>

## Range of Variables

**tools and equipment** include: dip sticks, sight glass, refractometers, test strips

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**fluids** include: hub oil, hydraulic oil, methyl hydrate, fuel, coolants, engine oil, brake fluids, washer fluids

**lubricants** include: oils and greases (synthetic, semi-synthetic, non-synthetic)

**fluid samples** include: oils, coolants, fuels, brake fluids, diesel exhaust fluids

**issues** include: contamination, abnormal wear, signs of premature failure

Knowledge		
	Learning Outcomes	Learning Objectives
A-3.02.01L	demonstrate knowledge of <b>fluids</b> and <b>lubricants</b> , their characteristics and applications	identify types and grades of <b>fluids</b> and <b>lubricants</b> , and describe their characteristics and applications
		describe consequences of mixing different types of <b>fluids</b> and <b>lubricants</b>
A-3.02.02L	demonstrate knowledge of procedures to maintain <b>fluids</b> and <b>lubricants</b>	identify <b>tools and equipment</b> used to maintain <b>fluids</b> and <b>lubricants</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>fluids</b> and <b>lubricants</b>
		describe procedures to maintain level of <b>fluids</b> and <b>lubricants</b>
		describe procedures to maintain coolants
		describe procedures to collect <b>fluid samples</b>



		describe procedures to dispose of and recycle oil, antifreeze, air conditioning refrigerant, contaminated fuels and filters
A-3.02.03L	demonstrate knowledge of regulatory requirements to recycle and dispose of oil, antifreeze, air conditioning refrigerant, contaminated fuels and filters	identify and interpret standards and regulations to recycle and dispose of oil, antifreeze, air conditioning refrigerant, contaminated fuels and filters
A-3.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to extending service intervals	identify practices that reduce material waste
		identify reusable filters

## Range of Variables

**fluids** include: hub oil, hydraulic oil, methyl hydrate, fuel, coolants, engine oil, brake fluids, washer fluids

**lubricants** include: oils and greases (synthetic, semi-synthetic, non-synthetic)

**tools and equipment** include: dip sticks, sight glass, refractometers, test strips

**hazards** include: caustic, respiratory, carcinogenic, poisoning

**fluid samples** include: oils, coolants, fuels, brake fluids, diesel exhaust fluids

## A-3.03 Services hoses, tubing and fittings

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-3.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
A-3.03.02P	support raised components mechanically, relieve pressure and drain fluid from air and fluid systems before disconnecting hoses, tubing and fittings	raised components are supported mechanically, pressure is relieved, and fluid is drained from air and fluid systems before disconnecting hoses, tubing and fittings according to service conditions and <b>manufacturers' service information</b>
A-3.03.03P	identify and document <b>faults</b>	<b>faults</b> are identified and documented according to sensory inspection of hoses, tubing and fittings
A-3.03.04P	route and secure hoses, tubing and fittings	hoses, tubing and fittings are routed and secured using <b>methods</b> to avoid rubbing, pinch/crush points or interference with other components
A-3.03.05P	identify and replace hoses and tubing	hoses and tubing are identified and replaced according to <b>application</b> and <b>manufacturers' service information</b>

A-3.03.06P	identify and replace fittings and clamping devices	fittings and clamping devices are identified and replaced according to thread, fitting size, compatibility and <b>manufacturers' service information</b>
A-3.03.07P	install ferrules, nuts and inserts	ferrules, nuts and inserts are installed according to design and application
A-3.03.08P	construct hose and tube assemblies	hose and tube assemblies are constructed using <b>tools and equipment</b>
A-3.03.09P	create flares	flares are created using specialized flaring tools

## Range of Variables

**tools and equipment** include: crimping tools, tube flaring tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**faults** include: holes, cracks, breakage, chaffing, leaks

**methods** include: using clamps, springs, separators and ties

**application** includes: size, pressure limits, fluid type, temperature

Knowledge		
	Learning Outcomes	Learning Objectives
A-3.03.01L	demonstrate knowledge of hoses, tubing and fittings, their characteristics, applications and operation	identify <b>types of hoses, tubing and fittings</b> , and describe their characteristics and applications
		describe operating principles of hoses, tubing and fittings
		describe compatibility of hoses, tubing and fittings
A-3.03.02L	demonstrate knowledge of procedures to service hoses, tubing and fittings	identify <b>tools and equipment</b> used to service hoses, tubing and fittings, and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to hoses, tubing and fittings
		describe procedures to inspect hoses, tubing and fittings
		describe procedures to remove and install hoses, tubing and fittings
A-3.03.03L	demonstrate knowledge of regulatory requirements pertaining to hoses, tubing and fittings	identify and interpret standards and regulations pertaining to hoses, tubing and fittings

## Range of Variables

**types of hoses, tubing and fittings** include: plastic, rubber, neoprene, steel

**tools and equipment** include: crimping tools, tube flaring tools

A-3.04		Services filters										
NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-3.04.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
A-3.04.02P	relieve system pressure before removing filters	system pressure is relieved before removing filters
A-3.04.03P	remove filters	filters are removed using tools and equipment according to <b>manufacturers' service information</b>
A-3.04.04P	identify performance issues and symptoms related to plugged filters	performance issues and symptoms related to plugged filters are identified to determine if replacement of filter is required
A-3.04.05P	inspect filters	filters are inspected for debris to determine condition of system
A-3.04.06P	select and install filters	filters are selected and installed according to <b>manufacturers' service information</b>
A-3.04.07P	dispose of filters	filters are disposed of according to jurisdictional regulations
A-3.04.08P	wash filters	filters are washed according to <b>manufacturers' service information</b>

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

Knowledge		
	Learning Outcomes	Learning Objectives
A-3.04.01L	demonstrate knowledge of filters, their characteristics, <b>applications</b> and operation	identify <b>types of filters</b> and describe their characteristics and <b>applications</b>
		describe operating principles of filters

A-3.04.02L	demonstrate knowledge of procedures to service filters	identify tools and equipment used to service filters, and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to filters
		describe procedures to inspect filters
		describe procedures to remove and install filters
		describe procedures to dispose of and recycle filters
A-3.04.03L	demonstrate knowledge of regulatory requirements to recycle and dispose of filters	identify and interpret standards and regulations to recycle and dispose of filters
A-3.04.04L	demonstrate knowledge of emerging technologies and practices pertaining to reusable filters	identify practices that reduce filter waste

### Range of Variables

**applications** include: air, fuel, oil

**types of filters** include: wash-out, pre-cleaners

## A-3.05 Services bearings and seals

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
A-3.05.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
A-3.05.02P	inspect <b>bearings</b> for <b>defects</b>	<b>bearings</b> are inspected for <b>defects</b>
A-3.05.03P	inspect <b>seals</b> for <b>defects</b> during installation	<b>seals</b> are inspected for <b>defects</b> during installation
A-3.05.04P	inspect <b>seals</b> and sealing surfaces for damage after installation	<b>seals</b> and sealing surfaces are inspected for damage after installation
A-3.05.05P	lubricate and install <b>bearings</b> and bushings	<b>bearings</b> and bushings are lubricated and installed to allowable tolerances according to application
A-3.05.06P	install <b>seals</b>	<b>seals</b> are installed according to <b>manufacturers' service information</b>
A-3.05.07P	adjust <b>bearings</b>	<b>bearings</b> are adjusted according to <b>manufacturers' service information</b>

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**bearings** include: friction, non-friction

**bearing defects** include: pitting, scoring, discolouration, excessive wear

**seals** include: static, dynamic

**seal defects** include: distortion, warped sealing surface, installation damage, brittleness

Knowledge		
	Learning Outcomes	Learning Objectives
A-3.05.01L	demonstrate knowledge of <b>bearings</b> and <b>seals</b> , their characteristics, applications and operation	identify types of <b>bearings</b> and <b>seals</b> , and describe their characteristics and applications
		describe operating principles of <b>bearings</b> and <b>seals</b>
A-3.05.02L	demonstrate knowledge of procedures to service <b>bearings</b> and <b>seals</b>	identify tools and equipment used to service <b>bearings</b> and <b>seals</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>bearings</b> and <b>seals</b>
		describe procedures to inspect <b>bearings</b> , <b>seals</b> and sealing surfaces
		describe procedures to service <b>bearings</b> and <b>seals</b>
		describe procedures to remove and install <b>bearings</b> and <b>seals</b>
		identify <b>types of shaft repairs</b>

## Range of Variables

**bearings** include: friction, non-friction

**seals** include: static, dynamic

**hazards** include: removal process, shards

**types of shaft repairs** include: installing wear sleeves, re-machining of shaft

## A-3.06 Uses fasteners and sealing devices

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
A-3.06.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
A-3.06.02P	select and install fasteners	fasteners are selected and installed according to <b>factors</b> and <b>manufacturers' service information</b>
A-3.06.03P	tighten fasteners	fasteners are tightened according to <b>manufacturers' service information</b>
A-3.06.04P	select and apply <b>sealing devices</b>	<b>sealing devices</b> are selected and applied according to application, environmental conditions and <b>manufacturers' service information</b>
A-3.06.05P	verify quality of fasteners and <b>sealing devices</b>	fasteners and <b>sealing devices</b> are verified according to <b>manufacturers' service information</b>
A-3.06.06P	remove broken fasteners while minimizing damage to threads	broken fasteners are removed while minimizing damage to threads
A-3.06.07P	repair threads	threads are repaired using <b>tools</b> according to <b>manufacturers' service information</b>
A-3.06.08P	remove <b>sealing devices</b> while minimizing damage to sealing surface	<b>sealing devices</b> are removed while minimizing damage to sealing surface
A-3.06.09P	fabricate and install <b>sealing devices</b>	<b>sealing devices</b> are fabricated and installed according to application and <b>manufacturers' service information</b>

### Range of Variables

**tools and equipment** include: rivet guns, impact guns, glue guns, torque wrenches, crimpers, air hammers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**factors** include: application, type, grade, thread pitch, size

**sealing devices** include: weather stripping, window channel, aerobic and anaerobic sealants, O-rings, compound gaskets, paper gaskets, head gaskets

**tools** include: taps, dies, chasers, thread inserts

Knowledge		
	Learning Outcomes	Learning Objectives
A-3.06.01L	demonstrate knowledge of fasteners, their characteristics, applications and operation	identify types, grades and torque specifications of fasteners, and describe their characteristics and applications
		describe operating principles of fasteners
A-3.06.02L	demonstrate knowledge of <b>sealing devices</b> , their characteristics and applications and operation	identify types of <b>sealing devices</b> , and describe their characteristics and applications
		describe operating principles of <b>sealing devices</b>
A-3.06.03L	demonstrate knowledge of procedures to apply, remove and install fasteners and <b>sealing devices</b>	identify <b>tools and equipment</b> used with fasteners and <b>sealing devices</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to fasteners and <b>sealing devices</b>
		identify <b>tools</b> used to repair threads
		describe procedures used to repair threads
		describe procedures to remove and install fasteners and <b>sealing devices</b>
		describe procedures to apply <b>sealing devices</b>
		describe torque procedures for fasteners
		identify anaerobic and aerobic materials, and describe their characteristics and applications
		identify ventilation requirements when using sealants and adhesives
A-3.06.04L	demonstrate knowledge of regulatory requirements pertaining to sealants and adhesives	identify and interpret standards and regulations pertaining to handling, storing and disposing of <b>sealing devices</b>

### Range of Variables

**sealing devices** include: weather stripping, window channel, aerobic and anaerobic sealants, O-rings, compound gaskets, paper gaskets, head gaskets

**tools and equipment** include: rivet guns, impact guns, glue guns, torque wrenches, crimpers, air hammers

**hazards** include: seal failure, fastener failure, irritants

**tools** include: taps, dies, chasers, thread inserts

## Task A-4 Uses communication and mentoring techniques

### Task Descriptor

Learning in the trades is done primarily in the workplace with tradespeople passing on their skills and knowledge to apprentices, as well as sharing knowledge among themselves. Apprenticeship is, and always has been about mentoring – learning workplace skills and passing them on. Because of the importance of this to the trade, this task covers the activities related to communication in the workplace and mentoring skills.

#### A-4.01 Uses communication techniques

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-4.01.01P	demonstrate communication practices with individuals or in a group	instructions and messages are interpreted by all parties involved in communication
A-4.01.02P	listen using <b>active listening</b> practices	<b>active listening</b> practices are used
A-4.01.03P	speak clearly using correct industry terminology to ensure understanding	understanding of message is confirmed by both parties
A-4.01.04P	receive and respond to instructions	response to instructions indicates understanding
A-4.01.05P	receive and respond to feedback on work completed or performed	response to feedback indicates understanding and corrective measures are taken
A-4.01.06P	explain and provide feedback	explanation and feedback are provided, and task is carried out as directed
A-4.01.07P	use questions to improve communication	questions enhance understanding, on-the-job training and goal setting
A-4.01.08P	participate in safety and information meetings	meetings are attended, information is relayed to workforce, and is applied
A-4.01.09P	send and receive <b>electronic messages</b>	<b>electronic messages</b> are sent and received using professionalism, plain language and clear expressions according to company policy

### Range of Variables

**active listening** includes: hearing, interpreting, reflecting, responding, paraphrasing

**electronic messages** include: e-mail, text messages



Knowledge		
	Learning Outcomes	Learning Objectives
A-4.01.01L	demonstrate knowledge of trade terminology	define terminology used in trade
A-4.01.02L	demonstrate knowledge of effective communication practices	describe importance of using effective verbal and non-verbal communication with <b>people in the workplace</b>
		identify <b>sources of information</b> to effectively communicate
		identify communication and <b>learning styles</b>
		describe effective listening and speaking skills
		describe how to receive and give instructions effectively
		identify <b>personal responsibilities and attitudes</b> that contribute to on-the-job success
		identify value of equity, diversity and inclusion in workplace
		identify communication that constitutes bullying, <b>harassment</b> and <b>discrimination</b>
		identify communication styles appropriate to different systems and applications of <b>electronic messages</b>

## Range of Variables

**people in the workplace** include: other tradespeople, colleagues, apprentices, supervisors, clients, jurisdictional representatives, manufacturers

**sources of information** include: regulations, codes, occupational health and safety requirements, jurisdictional requirements, prints, drawings, specifications, company and client documentation

**learning styles** include: visual, auditory, kinesthetic, reading, writing

**personal responsibilities and attitudes** include: asking questions, working safely, accepting constructive feedback, time management and punctuality, respect for authority, good stewardship of materials, tools and property, efficient work practice

**harassment:** as defined by the Canadian and jurisdictional Human Rights Commissions, workplace policies

**discrimination:** as defined by the Canadian Human Rights Act and jurisdictional human rights laws, workplace policies

**electronic messages** include: e-mail, text messages

## A-4.02 Uses mentoring techniques

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
A-4.02.01P	identify and communicate learning objective and point of lesson	apprentice or learner can explain objective and point of lesson
A-4.02.02P	link lesson to other lessons and project	lesson order and unplanned learning opportunities are defined
A-4.02.03P	demonstrate performance of a skill to an apprentice or learner	<b>steps required to demonstrate a skill</b> are performed
A-4.02.04P	set up conditions required for apprentice or learner to practice a skill	<b>practice conditions</b> are set up so that skill can be practiced safely by apprentice or learner
A-4.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice or learner improves with practice to a point where task can be done with little supervision
A-4.02.06P	give supportive and corrective feedback	apprentice or learner adopts best practice after having been given supportive or corrective feedback
A-4.02.07P	support apprentices or learners in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority
A-4.02.08P	support anti- <b>harassment</b> and anti- <b>discrimination</b> practices in workplace	workplace is <b>harassment-</b> and <b>discrimination-free</b>
A-4.02.09P	assess apprentice or learner suitability to trade during probationary period	apprentice or learner is given constructive feedback that helps them identify their own strengths and weaknesses and suitability for the trade

**steps required to demonstrate a skill** include: understanding who, what, where, when, why, and how, explaining, showing, giving encouragement, following up to ensure skill is performed correctly

**practice conditions** mean: guided, limited independence, full independence

**harassment:** as defined by the Canadian and jurisdictional Human Rights Commissions, workplace policies

**discrimination:** as defined by the Canadian Human Rights Act and jurisdictional human rights laws, workplace policies

Knowledge		
	Learning Outcomes	Learning Objectives
A-4.02.01L	demonstrate knowledge of strategies for learning skills in workplace	describe importance of individual experience
		describe shared responsibilities for workplace learning
		determine one's own learning preferences and explain how these relate to learning new skills
		describe importance of different types of skills in workplace
		describe importance of <b>skills for success (essential skills)</b> in workplace
		identify different <b>learning styles</b>
		identify different <b>learning needs</b> and strategies to meet them
		identify <b>strategies to assist in learning a skill</b>
A-4.02.02L	demonstrate knowledge of strategies for <b>teaching</b> workplace <b>skills</b>	identify different roles played by workplace mentor
		describe <b>teaching skills</b>
		explain importance of identifying point of lesson
		identify how to choose a good time to present lesson
		explain importance of linking lessons
		identify context for learning skills
		describe considerations in setting up opportunities for skill practice
		explain importance of providing feedback
		identify techniques for giving effective feedback
		describe a skills assessment
		identify methods of assessing progress
		explain how to adjust lesson to different situations

## Range of Variables

**skills for success (essential skills)** are: adaptability, collaboration, communication, creativity and innovation, digital, numeracy, problem solving, reading, writing

**learning styles** include: visual, auditory, kinesthetic, reading, writing

**learning needs** include: learning disabilities, learning preferences, language proficiency

**strategies to assist in learning a skill** include: understanding the basic principles of instruction, developing coaching skills, being mature and patient, providing feedback

**teaching skills** include: identifying point of lesson, linking lesson, demonstrating skill, providing practice, giving feedback, assessing skills and progress

# Major Work Activity B

## Services, diagnoses and repairs engines and supporting systems

### Task B-5 Services, diagnoses and repairs base engines

#### Task Descriptor

The engine produces power through engine speed and torque to enable movement of the vehicle. Servicing includes the adjustment of components as well as their routine maintenance. Diagnosing is required to locate failures in order to effectively perform repairs on the engine, which may include replacement or rebuilding of components.

Truck and transport mechanics service, diagnose and repair the base engine and its components to ensure proper engine function and reduce down time.

#### **B-5.01** Services base engines

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
B-5.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-5.01.02P	collect oil sample	oil sample is collected according to sample kit instructions and <b>manufacturers' service information</b>
B-5.01.03P	visually inspect oil sample and send sample for analysis	oil sample is visually inspected for residual contaminants and sample is sent for analysis according to company policies and customer request
B-5.01.04P	perform sensory inspection of base engine <b>components</b>	sensory inspection of base engine <b>components</b> is performed to identify wear, damage and defects

B-5.01.05P	adjust clearance of valve train components	clearance of valve train components is adjusted according to <b>manufacturers' service information</b>
B-5.01.06P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: blocks, crankshafts, camshafts, cylinder heads, pistons, bushings, rocker arms, gears, bearings

Knowledge		
	Learning Outcomes	Learning Objectives
B-5.01.01L	demonstrate knowledge of base engines, their <b>components</b> , characteristics, applications and operation	identify types of base engines and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of base engines and their <b>components</b>
		interpret information pertaining to base engines found in <b>manufacturers' service information</b>
B-5.01.02L	demonstrate knowledge of procedures to service base engines and their <b>components</b>	identify tools and equipment used to service base engines and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to base engines and their <b>components</b>
		describe procedures to inspect base engines and their <b>components</b>
		describe procedures to service base engines and their <b>components</b>
B-5.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to base engines	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technological improvements to base engine materials and design
		identify materials that can be reconditioned, reused or recycled

## Range of Variables

**components** include: blocks, crankshafts, camshafts, cylinder heads, pistons, bushings, rocker arms, gears, bearings

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: sharp edges, weight, size, heat, moving parts

### B-5.02 Diagnoses base engines

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
B-5.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-5.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-5.02.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
B-5.02.04P	perform diagnostic procedure	diagnostic procedure is performed to determine failure according to <b>manufacturers' service information</b>
B-5.02.05P	perform electronic and mechanical <b>tests</b>	electronic and mechanical <b>tests</b> are performed according to <b>manufacturers' service information</b> to assess components for wear, damage and defects
B-5.02.06P	interpret oil sample analysis results	oil sample analysis results are interpreted to determine specific <b>component</b> wear
B-5.02.07P	interpret <b>test</b> results	<b>test</b> results are interpreted and compared to <b>manufacturers' service information</b> or expected values
B-5.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-5.02.09P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-5.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: abnormal vibration, leaks, noises, no start, hard start, low power, low oil pressure

**tools and equipment** include: temperature measuring devices, compression testers, wear measuring instruments, pressure measuring devices, dynamometers, fluid analysis sampling devices, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: feeling for vibrations, listening for abnormal sounds, smelling for burning oil

**tests** include: compression tests, cylinder leakage, oil pressure, dynamometer checks, fluid sampling for analysis, injector cut-out

**components** include: valves, pistons, blocks, liners, cylinder heads, cam shafts, valve trains, crank shafts, connecting rods, gears, bearings, seals, sealants, gaskets

**next steps** include: repairs, component replacement, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-5.02.01L	demonstrate knowledge of base engines, their <b>components</b> , characteristics, applications and operation	identify types of base engines and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of base engines and their <b>components</b>
		interpret information pertaining to base engines found in <b>manufacturers' service information</b>
B-5.02.02L	demonstrate knowledge of procedures to diagnose base engines and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose base engines and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to base engines and their <b>components</b>
		describe procedures to inspect base engines and their <b>components</b>
		describe procedures to test base engines and their <b>components</b>
		describe procedures to diagnose base engines and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled



B-5.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to base engines	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technological improvements to base engine materials and design

## Range of Variables

**components** include: valves, pistons, blocks, liners, cylinder heads, cam shafts, valve trains, crank shafts, connecting rods, gears, bearings, seals, sealants, gaskets

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: temperature measuring devices, compression testers, wear measuring instruments, pressure measuring devices, dynamometers, fluid analysis sampling devices, electronic service tools

**hazards** include: sharp edges, weight, size, heat, moving parts

**symptoms of problems** include: abnormal vibration, leaks, noises, no start, hard start, low power, low oil pressure

## B-5.03 Repairs base engines

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-5.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-5.03.02P	prepare equipment for engine repair, removal and reinstallation procedures	equipment is prepared for engine repair, removal and reinstallation procedures by performing <b>functions</b>
B-5.03.03P	remove and replace worn, damaged or faulty <b>components</b>	worn, damaged or faulty <b>components</b> are removed and replaced
B-5.03.04P	perform updates	updates are performed according to <b>manufacturers' service information</b>
B-5.03.05P	rebuild cylinder head	cylinder head is rebuilt by cleaning and replacing worn <b>cylinder head components</b> according to <b>manufacturers' service information</b>
B-5.03.06P	rebuild base engine	base engine is rebuilt by cleaning and replacing worn or damaged <b>components</b>
B-5.03.07P	repair base engine	base engine is repaired using <b>methods</b> according to <b>manufacturers' service information</b>

B-5.03.08P	perform <b>adjustments</b>	<b>adjustments</b> are performed to ensure operation of components and equipment
B-5.03.09P	verify repairs	repairs are verified using <b>methods</b>
B-5.03.10P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: torque wrenches, dial indicators, measuring instruments, lifting devices, engine rotator, torque-to-yield gauge, feeler gauges, dynamometer, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**functions** include: disconnecting electrical connections, draining fluids, steam cleaning engine

**components** include: valves, pistons, piston rings, blocks, liners, cylinder heads, cam shafts, valve trains, crank shafts, connecting rods, timing gears, bearings, seals, sealants, gaskets

**cylinder head components** include: valves, seals, valve guides, valve seats, springs, injector sleeves/cups

**methods** (to repair base engine) include: replacing parts causing failure, grinding valves, cutting block counterbores and shimming cylinder liners, using oversized bearings

**adjustments** include: adjusting valve train clearances, setting timing gears

**methods** (to verify repairs) include: road testing, dynamometer testing, electronic diagnostic testing

Knowledge		
	Learning Outcomes	Learning Objectives
B-5.03.01L	demonstrate knowledge of base engines, their <b>components</b> , characteristics, applications and operation	identify types of base engines and their <b>components</b> , and describe their characteristics and applications
		describe theory of engine operation
B-5.03.02L	demonstrate knowledge of procedures to repair base engines and their <b>components</b>	identify <b>tools and equipment</b> used to repair base engines and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to base engines and their <b>components</b>
		describe procedures to remove, replace, rebuild and repair base engines and their <b>components</b>
		identify materials that can be reconditioned, reused or recycled
B-5.03.03L	demonstrate knowledge of training and certification requirements for base engine repair	identify manufacturers' training and certification requirements for base engine repair

B-5.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to base engines	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technological improvements to base engine materials and design

## Range of Variables

**components** include: valves, pistons, piston rings, blocks, liners, cylinder heads, cam shafts, valve trains, crank shafts, connecting rods, timing gears, bearings, seals, sealants, gaskets

**tools and equipment** include: torque wrenches, dial indicators, measuring instruments, lifting devices, engine rotator, torque-to-yield gauge, feeler gauges, dynamometer, electronic service tools

**hazards** include: sharp edges, weight, size, heat, moving parts

## Task B-6 Services, diagnoses and repairs lubrication systems

### Task Descriptor

The lubrication system regulates the flow of oil throughout the engine and its components to the oil cooler to transfer heat from the oil to the cooling system. It also flushes contaminants away from engine components through the oil filter. Its main purpose is to protect internal engine components by creating a thin film of oil between metal surfaces.

Servicing includes the replacement of consumables as well as the routine maintenance of the system. Diagnosing is required to determine the root cause of failures in order to effectively perform repairs on lubrication system.

Truck and transport mechanics service, diagnose and repair lubrication systems to ensure proper protection of the engine and its components.

### B-6.01 Services lubrication systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-6.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-6.01.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-6.01.03P	clean lubrication system <b>components</b>	lubrication system <b>components</b> are cleaned using lint-free rags and solvents

B-6.01.04P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged and defective <b>components</b>
B-6.01.05P	measure oil pressure, temperature and level	oil pressure, temperature and level are measured to determine if they meet <b>manufacturers' service information</b> and fleet/owner maintenance schedule
B-6.01.06P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>
B-6.01.07P	recycle or dispose of <b>consumables</b>	<b>consumables</b> are recycled or disposed of according to jurisdictional regulations
B-6.01.08P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: oil pump, oil cooler, pressure regulator valves, bypass valves, inlet strainers, oil filters

**sensory inspections** include: looking for leaks, smelling for burnt oil, checking magnetic drain plug for contamination

**consumables** include: oil filters, oil

Knowledge		
	Learning Outcomes	Learning Objectives
B-6.01.01L	demonstrate knowledge of lubrication systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of lubrication systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of lubrication systems and their <b>components</b>
		interpret information pertaining to lubrication systems found in <b>manufacturers' service information</b>
		describe functions and characteristics of engine oil
		identify <b>fluid classifications</b>
B-6.01.02L	demonstrate knowledge of procedures to service lubrication systems and their <b>components</b>	identify tools and equipment used to service lubrication systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to lubrication systems and their <b>components</b>

		describe procedures to release or isolate stored energy
		describe procedures to inspect lubrication systems and their <b>components</b>
		describe procedures to service lubrication systems and their <b>components</b>
		describe procedures to remove and replace lubrication system <b>components</b>
		describe procedures to remove, replace, recycle and dispose of lubrication system <b>consumables</b>
		identify materials that can be recycled
		identify practices that reduce material waste
B-6.01.03L	demonstrate knowledge of regulatory requirements pertaining to lubrication systems	identify and interpret standards and regulations pertaining to lubrication systems
B-6.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to lubrication systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: oil pump, oil cooler, pressure regulator valves, bypass valves, inlet strainers, oil filters

**consumables** include: oil filters, oil

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**fluid classifications** include: viscosity, American Petroleum Institute (API), Society of Automotive Engineers (SAE)

**hazards** include: high temperatures, skin irritation, splashing/dripping oil, fire

## B-6.02 Diagnoses lubrication systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-6.02.01P	identify <b><i>symptoms of problems</i></b>	<b><i>symptoms of problems</i></b> are identified by consulting with customer or operator
B-6.02.02P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
B-6.02.03P	release or isolate stored energy	stored energy is released or isolated according to <b><i>manufacturers' service information</i></b>
B-6.02.04P	perform <b><i>sensory inspections</i></b>	<b><i>sensory inspections</i></b> are performed to confirm complaint and establish preliminary diagnosis
B-6.02.05P	perform diagnostic procedures and <b><i>tests</i></b>	diagnostic procedures and <b><i>tests</i></b> are performed to determine failure by following <b><i>manufacturers' service information</i></b>
B-6.02.06P	interpret oil sample analysis results	oil sample analysis results are interpreted to determine contamination of lubricant
B-6.02.07P	compare <b><i>test</i></b> results to <b><i>manufacturers' service information</i></b> or expected values	<b><i>test</i></b> results are compared to <b><i>manufacturers' service information</i></b> or expected values to verify diagnosis
B-6.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-6.02.09P	record <b><i>test</i></b> results and inspection findings	<b><i>test</i></b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-6.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b><i>next steps</i></b>

## Range of Variables

**symptoms of problems** include: low or high fluid level, low or high oil pressure, external oil leaks, oil dilution, cross-contaminated oil, high oil temperature

**tools and equipment** include: pressure gauges, infrared/direct contact thermometers, dyes, fluid analysis sampling devices

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: listening for engine knock, smelling oil, looking for leaks, visual inspection of levels

**tests** include: oil pressure and temperature, contamination

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-6.02.01L	demonstrate knowledge of lubrication systems, their <b>components</b> , characteristics, applications and operation	identify types of lubrication systems and their <b>components</b> , and describe their characteristics, applications and operation
		describe operating principles of lubrication systems and their <b>components</b>
		interpret information pertaining to lubrication systems found in <b>manufacturers' service information</b>
B-6.02.02L	demonstrate knowledge of procedures to diagnose lubrication systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose lubrication systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to lubrication systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to inspect lubrication systems and their <b>components</b>
		describe procedures to test and diagnose lubrication systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be recycled
B-6.02.03L	demonstrate knowledge of regulatory requirements pertaining to lubrication system waste disposal	identify practices that reduce material waste
		identify and interpret standards and regulations pertaining to lubrication system waste disposal

B-6.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to lubrication systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: oil pump, oil cooler, pressure regulator valves, bypass valves, inlet strainers, oil filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: pressure gauges, infrared/direct contact thermometers, dyes, fluid analysis sampling devices

**hazards** include: high temperatures, skin irritation, splashing/dripping oil, fire

**symptoms of problems** include: low or high fluid level, low or high oil pressure, external oil leaks, oil dilution, cross-contaminated oil, high oil temperature

## B-6.03 Repairs lubrication systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-6.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-6.03.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-6.03.03P	remove and replace <b>components</b>	<b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
B-6.03.04P	verify repairs	repairs are verified using <b>methods</b> while running engine at operating condition
B-6.03.05P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking



## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: pumps, oil thermostats, piston cooling nozzles, bearings

**methods** include: checking oil pressure, temperature and levels

Knowledge		
	Learning Outcomes	Learning Objectives
B-6.03.01L	demonstrate knowledge of lubrication systems, their <b>components</b> , characteristics, applications and operation	identify types of lubrication systems, their <b>components</b> , and describe their characteristics, applications and operation
		describe operating principles of lubrication systems and their <b>components</b>
		interpret information pertaining to lubrication systems found in <b>manufacturers' service information</b>
B-6.03.02L	demonstrate knowledge of procedures to repair lubrication systems and their <b>components</b>	identify tools and equipment used to repair lubrication systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to lubrication systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to remove, replace and repair lubrication systems and their <b>components</b>
B-6.03.03L	demonstrate knowledge of regulatory requirements pertaining to lubrication system waste disposal	identify and interpret standards and regulations pertaining to lubrication system waste disposal
B-6.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to lubrication systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: pumps, oil thermostats, piston cooling nozzles, bearings

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: high temperatures, skin irritation, splashing/dripping oil, fire

## Task B-7 Services, diagnoses and repairs intake systems

### Task Descriptor

The engine intake systems supply cool filtered air to the engine. Emissions control systems are often an integral part of intake systems.

Servicing includes the replacement of consumables and components as well as their routine maintenance. Diagnosing is required to determine root cause of failures in order to effectively perform repairs on intake systems.

Truck and transport mechanics must service, diagnose and repair intake systems to ensure proper operation and performance of the engine.

### B-7.01 Services intake systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
B-7.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-7.01.02P	clean intake components	intake components are cleaned according to <b>manufacturers' service information</b>
B-7.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged and defective <b>components</b>
B-7.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
B-7.01.05P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of
B-7.01.06P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: looking for soot deposits indicating leaks, listening for air escaping, looking for incorrect fit or installation of piping, checking gauges

**components** include: charge air coolers (CAC), turbochargers (variable geometry turbochargers [VGT] and compound), piping, manifolds, gaskets, filter housing, clamps, pressure and temperature sensors, intake throttle valves

**consumables** include: gaskets, filters

Knowledge		
	Learning Outcomes	Learning Objectives
B-7.01.01L	demonstrate knowledge of intake systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of intake systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of intake systems and their <b>components</b>
		interpret information pertaining to intake systems found in <b>manufacturers' service information</b>
		identify types of <b>starting aids</b> and describe their characteristics, applications and safe use
B-7.01.02L	demonstrate knowledge of procedures to service intake systems, their <b>components</b> and <b>consumables</b>	identify tools and equipment used to service intake systems, their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to intake systems and their <b>components</b>
		describe procedures to inspect intake systems and their <b>components</b> and <b>consumables</b>
		describe procedures to service intake systems and their <b>components</b> and <b>consumables</b>
		describe procedures to remove, replace, recycle and dispose of intake system <b>consumables</b>
B-7.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to intake systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: charge air coolers (CAC), turbochargers (variable geometry turbochargers [VGT] and compound), piping, manifolds, gaskets, filter housing, clamps, pressure and temperature sensors, intake throttle valves

**consumables** include: gaskets, filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**starting aids** include: pre-heaters, ether injection

**hazards** include: running engine in confined spaces, dangers surrounding air inlets

### B-7.02 Diagnoses intake systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
B-7.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-7.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-7.02.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
B-7.02.04P	perform diagnostic procedure and <b>tests</b>	diagnostic procedure and <b>tests</b> are performed to determine failure according to <b>manufacturers' service information</b>
B-7.02.05P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
B-7.02.06P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-7.02.07P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-7.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>
B-7.02.09P	inspect and test <b>starting aids</b>	<b>starting aids</b> are inspected and tested according to <b>manufacturers' service information</b>

## Range of Variables

**symptoms of problems** include: visible exhaust smoke, low power, no start, low boost, noises

**tools and equipment** include: electronic service tools, intake CAC pressure test kits, manometers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: looking for soot deposits indicating leaks, listening for air escaping, looking for incorrect fit or installation of piping, checking gauges

**tests** include: boost test, intake and CAC pressure test, exhaust gas recirculation (EGR) operation test

**next steps** include: repairs, component replacement or adjustment, further diagnosis

**starting aids** include: pre-heaters, ether injection

Knowledge		
	Learning Outcomes	Learning Objectives
B-7.02.01L	demonstrate knowledge of intake systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of intake systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of intake systems and their <b>components</b>
		interpret information pertaining to intake systems found in <b>manufacturers' service information</b>
		identify types of <b>starting aids</b> and describe their characteristics, applications and safe use
		identify <b>intake system contamination</b>
B-7.02.02L	demonstrate knowledge of procedures to diagnose intake systems and their <b>components</b>	identify <b>emergency shutdown devices</b>
		identify <b>tools and equipment</b> used to diagnose intake systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to intake systems and their <b>components</b>
		describe procedures to inspect intake systems and their <b>components</b>
		describe procedures to test intake systems and their <b>components</b>
		describe procedures to diagnose intake systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>

B-7.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to intake systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: CAC, turbochargers (VGT and compound), piping, manifolds, gaskets, filter housing, clamps, pressure and temperature sensors, intake throttle valve

**consumables** include: gaskets, filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**starting aids** include: pre-heaters, ether injection

**intake system contamination** includes: dust, oil, antifreeze

**emergency shutdown devices** include: air dams (cable and switch operated)

**tools and equipment** include: electronic service tools, intake CAC pressure test kits, manometers

**hazards** include: running engine in confined spaces, dangers surrounding air inlets

**symptoms of problems** include: visible exhaust smoke, low power, no start, low boost, noises

## B-7.03 Repairs intake systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-7.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-7.03.02P	remove and replace worn, damaged or faulty <b>components</b>	worn, damaged or faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
B-7.03.03P	remove and replace worn, damaged or faulty starting aid components	worn, damaged or faulty starting aid components are removed and replaced according to <b>manufacturers' service information</b>
B-7.03.04P	calibrate intake <b>electronic components</b>	intake <b>electronic components</b> are calibrated according to <b>manufacturers' service information</b>

B-7.03.05P	verify repairs	repairs are verified using <b>methods</b> according to <b>manufacturers' service information</b>
B-7.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: CAC, turbochargers (VGT and compound), piping, manifolds, gaskets, filter housing, clamps, pressure and temperature sensors, intake throttle valves

**electronic components** include: intake throttle valves, VGT, EGR

**methods** include: pressure testing intake system, performing sensory observations of intake system

Knowledge		
	Learning Outcomes	Learning Objectives
B-7.03.01L	demonstrate knowledge of intake systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of intake systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of intake systems and their <b>components</b>
		interpret information pertaining to intake systems found in <b>manufacturers' service information</b>
B-7.03.02L	demonstrate knowledge of procedures to repair intake systems and their <b>components</b>	identify tools and equipment used to repair intake systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to intake systems and their <b>components</b>
		describe procedures to remove, replace and repair intake systems and their <b>components</b>
B-7.03.03L	demonstrate knowledge of training and certification requirements pertaining to intake systems	identify training and certification pertaining to intake systems
B-7.03.04L	demonstrate knowledge of regulations pertaining to intake systems	identify and interpret regulations pertaining to intake systems
B-7.03.05L	demonstrate knowledge of emerging technologies and practices pertaining to intake systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: CAC, turbochargers (VGT and compound), piping, manifolds, gaskets, filter housing, clamps, pressure and temperature sensors, intake throttle valves

**consumables** include: gaskets, filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: running engine in confined spaces, dangers surrounding air inlets

## Task B-8 Services, diagnoses and repairs exhaust systems

### Task Descriptor

Exhaust systems work in conjunction with other engine systems to reduce noise pollution, nitric oxide and nitrogen dioxide (NO<sub>x</sub> gases), carbon emissions and other harmful by-products of combustion to meet jurisdictional environmental requirements.

Servicing includes the replacement of consumables and components as well as their routine maintenance. Diagnosing is required to determine root cause of failures in order to effectively perform repairs on exhaust systems.

Truck and transport mechanics service, diagnose and repair exhaust systems to ensure proper operation and performance of the engine, and to ensure emissions levels meet requirements.

### B-8.01 Services exhaust systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
B-8.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-8.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
B-8.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged or defective <b>components</b>
B-8.01.04P	perform software updates and reset electronic service reminders	software updates are performed and electronic service reminders are reset according to <b>manufacturers' service information</b>
B-8.01.05P	remove and replace <b>components</b> and <b>consumables</b>	<b>components</b> and <b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule



B-8.01.06P	recycle and dispose of <b>components</b> and <b>consumables</b>	<b>components</b> and <b>consumables</b> are recycled and disposed of according to jurisdictional regulations
B-8.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: electronic service tools, temperature and pressure measuring devices, diesel exhaust fluid (DEF) refractometer, diesel particulate filter (DPF) cleaning machines

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: DPFs, fluid dosing pump, pressure differential and temperature sensors, DEF injectors, catalysts, EGR valves and coolers, turbochargers (VGT and compound), exhaust manifolds

**sensory inspections** include: looking for leaks, observing DEF levels, looking for accumulation of urea crystals, looking for visible exhaust smoke

**consumables** include: DEF, filters

Knowledge		
	Learning Outcomes	Learning Objectives
B-8.01.01L	demonstrate knowledge of exhaust systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of exhaust systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		identify <b>types of emission systems</b>
		describe operating principles of exhaust systems and their <b>components</b>
		interpret information pertaining to exhaust systems found in <b>manufacturers' service information</b>
		identify <b>types of controls</b> and describe their characteristics and applications
B-8.01.02L	demonstrate knowledge of procedures to service exhaust systems, their <b>components</b> and <b>consumables</b>	identify <b>tools and equipment</b> used to service exhaust systems, their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to exhaust systems and their <b>components</b>
		describe procedures to inspect exhaust systems and their <b>components</b>
		describe procedures to clean exhaust system <b>components</b>
		describe procedures to remove, replace, recycle and dispose of exhaust system <b>consumables</b>

		describe procedures to perform software updates
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
B-8.01.03L	demonstrate knowledge of regulatory requirements pertaining to exhaust systems	identify and interpret standards and regulations pertaining to exhaust systems
B-8.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to exhaust systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: DPFs, fluid dosing pump, pressure differential and temperature sensors, DEF injectors, catalysts, EGR valves and coolers, turbochargers (VGT and compound), exhaust manifolds

**consumables** include: DEF, filters

**types of emission systems** include: DPF, EGR, selective catalytic reduction (SCR), crankcase ventilation systems

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of controls** include: electronic control management systems, electronic and manual switches

**tools and equipment** include: electronic service tools, temperature and pressure measuring devices, DEF refractometer, DPF cleaning machines

**hazards** include: skin and eye irritation, high temperature, hazardous fumes, operating engine in confined spaces

## B-8.02 Diagnoses exhaust systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-8.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-8.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-8.02.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis

B-8.02.04P	perform diagnostic procedure and <b>tests</b>	diagnostic procedure and <b>tests</b> are performed by following <b>manufacturers' service information</b>
B-8.02.05P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
B-8.02.06P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-8.02.07P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-8.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: leaks, low power, visible exhaust smoke, frequent regeneration, warning lights, fault codes

**tools and equipment** include: electronic service tools, temperature and pressure measuring devices

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: looking for leaks, observing DEF levels, looking for accumulation of urea crystals, looking for visible exhaust smoke

**tests** include: computer-based tests, DEF concentration tests, manual temperature and pressure gauge tests

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-8.02.01L	demonstrate knowledge of exhaust systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of exhaust systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of exhaust systems and their <b>components</b>
		interpret information pertaining to exhaust systems found in <b>manufacturers' service information</b>
		identify <b>types of emission systems</b>
		identify <b>types of controls</b> and describe their characteristics and applications
B-8.02.02L	demonstrate knowledge of procedures to diagnose exhaust systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose exhaust systems and their <b>components</b> , and describe their applications and procedures for use

		identify <b>hazards</b> and describe safe work practices pertaining to exhaust systems and their <b>components</b>
		describe procedures to diagnose exhaust systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
B-8.02.03L	demonstrate knowledge of regulatory requirements pertaining to exhaust systems	identify and interpret standards and regulations pertaining to exhaust systems
B-8.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to exhaust systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: DPFs, fluid dosing pump, pressure differential and temperature sensors, DEF injectors, catalysts, EGR valves and coolers, turbochargers (VGT and compound), exhaust manifolds

**consumables** include: DEF, filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of emission systems** include: DPF, EGR, SCR, crankcase ventilation systems

**types of controls** include: electronic control management systems, electronic and manual switches

**tools and equipment** include: electronic service tools, temperature and pressure measuring devices

**hazards** include: skin and eye irritation, high temperature, hazardous fumes, operating engine in confined spaces, noises

**symptoms of problems** include: leaks, low power, visible exhaust smoke, frequent regeneration, warning lights, fault codes

## B-8.03 Repairs exhaust systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-8.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-8.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
B-8.03.03P	perform updates	updates are performed according to <b>manufacturers' service information</b>
B-8.03.04P	reprogram parameters after repair	parameters are reprogrammed after repair according to <b>manufacturers' service information</b>
B-8.03.05P	verify repairs	repairs are verified using <b>methods</b>
B-8.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: DPF cleaning units, manufacturer-specific tools, welding equipment, electronic service tools, temperature and pressure measuring devices

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: DPFs, fluid dosing pump, pressure differential and temperature sensors, DEF injectors, catalysts, EGR valves and coolers, turbochargers (VGT and compound), exhaust manifolds

**methods** include: operating vehicle, parked regeneration, monitoring operation

### Knowledge

	Learning Outcomes	Learning Objectives
B-8.03.01L	demonstrate knowledge of exhaust systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of exhaust systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of exhaust systems and their <b>components</b>
		interpret information pertaining to exhaust systems found in <b>manufacturers' service information</b>
		identify <b>types of emissions systems</b>

		identify <b>types of controls</b> and describe their characteristics and applications
B-8.03.02L	demonstrate knowledge of procedures to repair exhaust systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair exhaust systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to exhaust systems and their <b>components</b>
		describe procedures to remove, replace and repair exhaust system <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
B-8.03.03L	demonstrate knowledge of regulatory requirements pertaining to exhaust systems	identify and interpret standards and regulations pertaining to exhaust systems
B-8.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to exhaust systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: DPFs, fluid dosing pump, pressure differential and temperature sensors, DEF injectors, catalysts, EGR valves and coolers, turbochargers (VGT and compound), exhaust manifolds

**consumables** include: DEF, filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of emission systems** include: DPF, EGR, SCR, crankcase ventilation systems

**types of controls** include: electronic control management systems, electronic and manual switches

**tools and equipment** include: DPF cleaning units, manufacturer-specific tools, welding equipment, electronic service tools, temperature and pressure measuring devices

**hazards** include: skin and eye irritation, high temperature, hazardous fumes, operating engine in confined spaces

## Task B-9 Services, diagnoses and repairs engine management systems

### Task Descriptor

Engine management systems receive analog/digital inputs and distribute analog/digital outputs to many components throughout the vehicle to optimize vehicle performance.

Servicing is primarily a matter of updating software to meet both manufacturer programming and fleet/owner requirements. Diagnosing is required to determine root cause of failures in order to effectively perform repairs on engine management systems.

Truck and transport mechanics service, diagnose and repair engine management systems to ensure proper operation of multiple components of the vehicle.

### B-9.01 Services engine management systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
B-9.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-9.01.02P	adjust values of electronic control module ( <b>ECM</b> ) <b>parameters</b>	values of <b>ECM parameters</b> are adjusted according to <b>manufacturers' service information</b> and fleet/owner requirements
B-9.01.03P	perform software updates	engine management system software updates are performed according to <b>manufacturers' service information</b>

### Range of Variables

**tools and equipment** include: electronic service tools, multimeters, breakout harnesses

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**ECM parameters** include: shutdowns, cruise controls, speed controls, fan controls, application specific (e.g., enabling PTO, geo-fencing, retarder, shift points)

Knowledge		
	Learning Outcomes	Learning Objectives
B-9.01.01L	demonstrate knowledge of engine management systems, their <b>components</b> , characteristics, applications and operation	identify engine management systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of engine management systems and their <b>components</b>
		describe effect of static electricity and external voltage induction on delicate electronic components
B-9.01.02L	demonstrate knowledge of procedures to service engine management systems and their <b>components</b>	identify <b>tools and equipment</b> used to service engine management systems and their <b>components</b> , and describe their applications and procedures for use
		describe procedures to service engine management systems and their <b>components</b>
		describe procedures to perform software updates
B-9.01.03L	demonstrate knowledge of training and certification requirements pertaining to engine management systems	identify training and certification requirements pertaining to engine management systems
B-9.01.04L	demonstrate knowledge of regulatory requirements pertaining to engine management systems	identify codes, standards and regulations pertaining to engine management systems
B-9.01.05L	demonstrate knowledge of emerging technologies and practices pertaining to engine management systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to engine management systems and safe vehicle operation

### Range of Variables

**components** include: harnesses, ECMs, switches, sensors, actuators

**tools and equipment** include: electronic service tools, multimeters, breakout harnesses



## B-9.02 Diagnoses engine management systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
B-9.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-9.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-9.02.03P	perform sensory inspections	sensory inspections are performed to confirm complaint and establish preliminary diagnosis
B-9.02.04P	perform diagnostic procedure	diagnostic procedure is performed to determine <b>failures</b> by following <b>manufacturers' service information</b>
B-9.02.05P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>
B-9.02.06P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
B-9.02.07P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-9.02.08P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-9.02.09P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

### Range of Variables

**symptoms of problems** include: misfires, gauges with readings outside expected range, engine shutdowns, no start, de-rated power, fault codes, warning lights

**tools and equipment** include: electronic service tools, multimeters, pin-out equipment, break-out harnesses

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**failures** include: poor connections, chafed or corroded harnesses, faulty components

**tests** include: resistance, voltage drop, commanded actuator

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-9.02.01L	demonstrate knowledge of engine management systems, their <b>components</b> , characteristics, applications and operation	<p>identify engine management systems and their <b>components</b>, and describe their characteristics and applications</p> <p>describe operating principles of engine management systems and their <b>components</b></p> <p>interpret information pertaining to engine management systems found in <b>manufacturers' service information</b></p> <p>describe effect of static electricity and external voltage induction on delicate electronic components</p> <p>identify <b>types of specialized connectors and harnesses</b></p> <p>identify spark ignition system components, and describe their characteristics and applications</p> <p>describe elements of manufacturers' engine ratings</p>
B-9.02.02L	demonstrate knowledge of procedures to diagnose engine management systems and their <b>components</b>	<p>identify <b>tools and equipment</b> used to diagnose engine management systems and their <b>components</b>, and describe their applications and procedures for use</p> <p>identify <b>hazards</b> and describe safe work practices pertaining to engine management systems and their <b>components</b></p> <p>describe procedures to inspect engine management systems and their <b>components</b></p> <p>describe procedures to test engine management systems and their <b>components</b></p> <p>describe procedures to diagnose engine management systems and their <b>components</b></p> <p>describe common causes and <b>symptoms of problems</b> and <b>failures</b></p>
B-9.02.03L	demonstrate knowledge of training and certification requirements pertaining to engine management systems	identify training and certification requirements pertaining to engine management systems
B-9.02.04L	demonstrate knowledge of regulatory requirements pertaining to engine management systems	identify codes, standards and regulations pertaining to engine management systems

B-9.02.05L	demonstrate knowledge of emerging technologies and practices pertaining to engine management systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to engine management systems and safe vehicle operation

## Range of Variables

**components** include: harnesses, ECMs, switches, sensors, actuators

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of specialized connectors and harnesses** include: sensor connections, injector harnesses, ECM connectors

**tools and equipment** include: electronic service tools, multimeters, pin-out equipment, break-out harnesses

**hazards** include: high-voltage outputs, hot surfaces, sharp edges, pinch/crush points, moving parts

**symptoms of problems** include: misfires, gauges with readings outside expected range, engine shutdowns, no start, de-rated power, fault codes, warning lights

**failures** include: poor connections, chafed or corroded harnesses, faulty components

## B-9.03 Repairs engine management systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-9.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-9.03.02P	remove and replace damaged and faulty <b>components</b>	damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
B-9.03.03P	perform updates and recalls	updates and recalls are performed according to <b>manufacturers' service information</b>
B-9.03.04P	repair <b>components</b>	<b>components</b> are repaired by soldering, splicing and crimping according to <b>manufacturers' service information</b>
B-9.03.05P	calibrate <b>components</b>	<b>components</b> are calibrated according to <b>manufacturers' service information</b>

B-9.03.06P	verify repairs	repairs are verified using <b>methods</b>
B-9.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: ECMs, harnesses, sensors, actuators, resistors, switches

**components** (to be repaired) include: harnesses, connectors, terminals

**components** (to be calibrated) include: injectors, turbochargers, speed control sensors, EGR valves, intake throttle valves, exhaust sensors

**methods** include: clearing codes, resetting virtual breaker, verifying that fault codes remain inactive, performing operational tests

Knowledge		
	Learning Outcomes	Learning Objectives
B-9.03.01L	demonstrate knowledge of engine management systems, their <b>components</b> , characteristics, applications and operation	identify engine management systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of engine management systems and their <b>components</b>
B-9.03.02L	demonstrate knowledge of procedures to repair engine management systems and their <b>components</b>	identify tools and equipment used to repair engine management systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to engine management systems and their <b>components</b>
		describe procedures to remove, replace, calibrate and repair engine management system <b>components</b>
B-9.03.03L	demonstrate knowledge of training and certification requirements pertaining to engine management systems	identify training and certification requirements pertaining to engine management systems
B-9.03.04L	demonstrate knowledge of regulatory requirements pertaining to engine management systems	identify codes, standards and regulations pertaining to engine management systems

B-9.03.05L	demonstrate knowledge of emerging technologies and practices pertaining to engine management systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to engine management systems and safe vehicle operation

## Range of Variables

**components** include: ECMs, harnesses, sensors, actuators, resistors, switches

intake throttle valves, exhaust sensors

**hazards** include: high-voltage outputs, hot surfaces, sharp edges, pinch/crush points, moving parts

## Task B-10 Services, diagnoses and repairs fuel delivery systems

### Task Descriptor

The fuel delivery system supplies clean fuel to the engine at regulated pressure and volume. Fuels include diesel, propane, bio-diesel and natural gas.

Truck and transport mechanics service, diagnose and repair fuel delivery systems to ensure proper engine operation and minimize downtime.

### B-10.01 Services fuel delivery systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
B-10.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
B-10.01.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-10.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged or defective <b>components</b>

B-10.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
B-10.01.05P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
B-10.01.06P	prime fuel system for operation	fuel system is primed for operation according to <b>manufacturers' service information</b>
B-10.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: smelling or looking for fuel leaks, looking for excessive exhaust smoke, listening for engine miss

**components** include: pumps, injectors, tanks, check valves, fuel regulating valves, lines

**consumables** include: fuels, filters, fuel-water separators, fuel additives

Knowledge		
	Learning Outcomes	Learning Objectives
B-10.01.01L	demonstrate knowledge of fuel delivery systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of fuel delivery systems</b> , their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of fuel delivery systems and their <b>components</b>
		identify <b>types of fuels</b> and describe their characteristics and applications
		identify <b>types of fuel additives</b> and describe their characteristics, applications and effects
		interpret information pertaining to fuel additives found in <b>manufacturers' service information</b>
B-10.01.02L	demonstrate knowledge of procedures to service fuel delivery systems, their <b>components</b> and <b>consumables</b>	identify tools and equipment used to service fuel delivery systems, their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to fuel delivery systems and their <b>components</b>
		describe procedures to release or isolate stored energy

		describe procedures to inspect fuel delivery systems and their <b>components</b>
		describe procedures to remove, replace recycle and dispose of fuel delivery system <b>consumables</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
B-10.01.03L	demonstrate knowledge of training and certification requirements pertaining to fuel delivery systems	identify training and certification requirements pertaining to fuel delivery systems
B-10.01.04L	demonstrate knowledge of regulatory requirements pertaining to fuel delivery systems	identify and interpret regulations pertaining to fuel delivery systems
B-10.01.05L	demonstrate knowledge of emerging technologies and practices pertaining to fuel delivery systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: pumps, injectors, tanks, check valves, fuel regulating valves, lines

**consumables** include: fuels, filters, fuel-water separators, fuel additives

**types of fuel delivery systems** include: mechanical, electronic

**types of fuels** include: winter and summer fuels, natural gas, propane, diesel, biodiesel, gasoline

**types of fuel additives** include: cetane boost, antigel/antiwax, fuel conditioner

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: extreme high pressure, flammable and explosive materials, environmental irritant, noxious fumes

## B-10.02 Diagnoses fuel delivery systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-10.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-10.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>

B-10.02.03P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-10.02.04P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
B-10.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
B-10.02.06P	interpret fuel system flow schematics and perform <b>tests</b>	fuel system flow schematics are interpreted and <b>tests</b> are performed according to <b>manufacturers' service information</b>
B-10.02.07P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
B-10.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-10.02.09P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-10.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: exhaust smoke, rough running engine, poor engine performance, no start, fuel leaks

**tools and equipment** include: pressure gauges, vacuum gauges, flow meters, dynamometers, electronic service tools, injector testers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: smelling and looking for leaks, listening for engine misfires and vibrations, looking for excessive exhaust smoke

**tests** include: injector cut-out, injector performance, transfer pump pressure, return volume, filter restriction, injector leakage

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-10.02.01L	demonstrate knowledge of fuel delivery systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of fuel delivery systems</b> , their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of fuel delivery systems and their <b>components</b>



		interpret information pertaining to fuel delivery systems found in <b>manufacturers' service information</b>
		identify <b>types of fuels</b> and describe their characteristics and applications
		identify <b>types of fuel additives</b> and describe their characteristics and applications
		interpret information pertaining to fuel additives found in <b>manufacturers' service information</b>
B-10.02.02L	demonstrate knowledge of procedures to diagnose fuel delivery systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose fuel delivery systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to fuel delivery systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to inspect fuel delivery systems and their <b>components</b>
		describe procedures to test fuel delivery systems and their <b>components</b>
		describe procedures to test fuels
		describe procedures to diagnose fuel delivery systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
B-10.02.03L	demonstrate knowledge of training and certification requirements pertaining to fuel delivery systems	identify training and certification requirements pertaining to fuel delivery systems
B-10.02.04L	demonstrate knowledge of regulatory requirements pertaining to fuel delivery systems	identify and interpret regulations pertaining to fuel delivery systems
B-10.02.05L	demonstrate knowledge of emerging technologies and practices pertaining to fuel delivery systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: pumps, injectors, tanks, check valves, fuel regulating valves, lines

**consumables** include: fuels, filters, fuel-water separators

**types of fuel delivery systems** include: mechanical, electronic

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of fuels** include: winter and summer fuels, natural gas, propane, diesel, biodiesel, gasoline

**types of fuel additives** include: cetane boost, antigel/antiwax, fuel conditioners

**tools and equipment** include: pressure gauges, vacuum gauges, flow meters, dynamometers, electronic service tools, injector testers

**hazards** include: extreme high pressure, flammable and explosive materials, environmental irritant, noxious fumes

**symptoms of problems** include: exhaust smoke, rough running engine, poor engine performance, no start, fuel leaks

### B-10.03 Repairs fuel delivery systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
B-10.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-10.03.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-10.03.03P	remove and replace worn, damaged or faulty <b>components</b>	worn, damaged or faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
B-10.03.04P	perform updates, recalls and recalibration	updates, recalls and recalibration are performed according to <b>manufacturers' service information</b>
B-10.03.05P	perform <b>measurements</b>	<b>measurements</b> are performed to determine if they meet <b>manufacturers' service information</b>
B-10.03.06P	perform <b>adjustments</b> to components	<b>adjustments</b> are performed on components according to <b>manufacturers' service information</b>
B-10.03.07P	prime fuel system for operation	fuel system is primed for operation according to <b>manufacturers' service information</b>

B-10.03.08P	verify repairs	repairs are verified using <b>methods</b>
B-10.03.09P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: torque wrenches, manufacturer-specific tools, pullers, dial indicators, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: low- and high-pressure pumps, injectors, tanks, check valves, fuel regulating valves, lines

**measurements** include: injector height, fuel pressure, pump inlet restriction

**adjustments** include: entering calibration values for electronic injectors, setting injector pre-load, confirming high and low throttle (mechanical injection systems), adjusting throttle linkages, setting injector height, setting pump timing

**methods** include: running equipment at operating condition, performing manufacturers' test procedures

Knowledge		
	Learning Outcomes	Learning Objectives
B-10.03.01L	demonstrate knowledge of fuel delivery systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of fuel delivery systems</b> , their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of fuel delivery systems and their <b>components</b>
		identify <b>types of fuels</b> and describe their characteristics and applications
B-10.03.02L	demonstrate knowledge of procedures to repair fuel delivery systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair fuel delivery systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to fuel delivery systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to remove, replace, calibrate, adjust and repair fuel delivery system <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
B-10.03.03L	demonstrate knowledge of training and certification requirements pertaining to fuel delivery systems	identify training and certification requirements pertaining to fuel delivery systems

B-10.03.04L	demonstrate knowledge of regulatory requirements pertaining to fuel delivery systems	identify and interpret regulations pertaining to fuel delivery systems
B-10.03.05L	demonstrate knowledge of emerging technologies and practices pertaining to fuel delivery systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: low- and high-pressure pumps, injectors, tanks, check valves, fuel regulating valves, lines

**consumables** include: fuels, filters, fuel-water separators

**types of fuel delivery systems** include: mechanical, electronic

**types of fuels** include: winter and summer fuels, natural gas, propane, diesel, biodiesel, gasoline

**tools and equipment** include: torque wrenches, manufacturer-specific tools, pullers, dial indicators, electronic service tools

**hazards** include: extreme high pressure, flammable and explosive materials, environmental irritant, noxious fumes

## Task B-11 Services, diagnoses and repairs engine retarder systems

### Task Descriptor

Engine retarder systems are an optional component used to assist the primary braking system to slow the vehicle and to prolong primary brake life. These systems receive inputs from the vehicle and operator to determine appropriate timing to manage compression within the engine by controlling exhaust flow or valve position.

Truck and transport mechanics service, diagnose and repair engine retarder systems to ensure proper function and reduce down time.

#### B-11.01 Services engine retarder systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
B-11.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-11.01.02P	perform <b>adjustments</b> to components	<b>adjustments</b> are performed on components according to <b>manufacturers' service information</b> and operator preferences
B-11.01.03P	perform ECM programming	ECM programming is performed according to fleet/owner requirements
B-11.01.04P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**tools and equipment** include: manufacturer-specific gauges, feeler gauge

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**adjustments** include: valve clearances, parameters, compression brake clearances

Knowledge		
Learning Outcomes		Learning Objectives
B-11.01.01L	demonstrate knowledge of engine retarder systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of engine retarder systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of engine retarder systems and their <b>components</b>
		describe function of electronic controls used with engine retarder systems
B-11.01.02L	demonstrate knowledge of procedures to service engine retarder systems and their <b>components</b>	identify <b>tools and equipment</b> used to service engine retarder systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to engine retarder systems and their <b>components</b>
		describe procedures to service engine retarder system <b>components</b>
		describe procedures to perform ECM programming
		describe procedures to test engine retarder systems and their <b>components</b>

### Range of Variables

**types of engine retarder systems** include: compression, exhaust

**components** include: harnesses, exhaust valves, secondary pistons, ECMs, solenoids, switches, O-rings

**tools and equipment** include: manufacturer-specific gauges, feeler gauge

**hazards** include: high temperatures, skin irritation, moving parts, sharp edges

### B-11.02 Diagnoses engine retarder systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
Performance Criteria		Evidence of Attainment
B-11.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-11.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>

B-11.02.03P	perform sensory inspections	sensory inspections are performed to confirm complaint and establish preliminary diagnosis
B-11.02.04P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
B-11.02.05P	perform <b>tests</b>	<b>tests</b> are performed to assess components for wear, damage and defects
B-11.02.06P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
B-11.02.07P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-11.02.08P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-11.02.09P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: poor engine retarder performance, unusual engine noises, loss of oil pressure

**tools and equipment** include: electronic service tools, pressure testing equipment, multimeters, feeler gauges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tests** include: oil pressure, solenoid operation, electrical circuitry, functionality

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-11.02.01L	demonstrate knowledge of engine retarder systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of engine retarder systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of engine retarder systems and their <b>components</b>
		interpret information pertaining to engine retarder systems found in <b>manufacturers' service information</b>
		describe function of electronic controls used with engine retarder systems

B-11.02.02L	demonstrate knowledge of procedures to diagnose engine retarder systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose engine retarder systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to engine retarder systems and their <b>components</b>
		describe procedures to inspect engine retarder systems and their <b>components</b>
		describe procedures to test engine retarder systems and their <b>components</b>
		describe procedures to diagnose engine retarder systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>

## Range of Variables

**components** include: harnesses, exhaust valves, secondary pistons, ECMs, solenoids, switches

**types of engine retarder systems** include: compression, exhaust

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: electronic service tools, pressure testing equipment, multimeters, feeler gauges

**hazards** include: high temperatures, skin irritation, moving parts, sharp edges

**symptoms of problems** include: poor engine retarder performance, unusual engine noises, loss of oil pressure

## B-11.03 Repairs engine retarder systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-11.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-11.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
B-11.03.03P	perform ECM software updates	ECM software updates are performed according to <b>manufacturers' service information</b>
B-11.03.04P	repair harnesses	harnesses are repaired according to <b>manufacturers' service information</b>



B-11.03.05P	perform <b>adjustments</b> to components	<b>adjustments</b> are performed on components according to <b>manufacturers' service information</b>
B-11.03.06P	verify repairs	repairs are verified using <b>methods</b>
B-11.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: electronic service tools, pressure testing equipment, multimeter, feeler gauges, manufacturer-specific tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: harnesses, exhaust valves, secondary pistons, ECMs, solenoids, switches

**adjustments** include: valve clearances, parameters, exhaust brake, compression brake clearances

**methods** include: road testing, function testing

Knowledge		
	Learning Outcomes	Learning Objectives
B-11.03.01L	demonstrate knowledge of engine retarder systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of engine retarder systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of engine retarder systems and their <b>components</b>
		describe function of electronic controls used with engine retarder systems
B-11.03.02L	demonstrate knowledge of procedures to repair engine retarder systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair engine retarder systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to engine retarder systems and their <b>components</b>
		describe procedures to remove, replace, adjust and repair engine retarder system <b>components</b>
		describe procedures to perform software updates

## Range of Variables

**components** include: harnesses, exhaust valves, secondary pistons, ECMs, solenoids, switches

**types of engine retarder systems** include: compression, exhaust

**tools and equipment** include: electronic service tools, pressure testing equipment, multimeter, feeler gauges, manufacturer-specific tools

**hazards** include: high temperatures, skin irritation, moving parts, sharp edges

## Task B-12 Services, diagnoses and repairs cooling systems

### Task Descriptor

The cooling system regulates the circulation of coolant throughout the engine and other components to the radiator to transfer heat from the engine to the atmosphere and the heating, ventilation and air conditioning (HVAC) system.

Servicing includes the replacement of consumables and components as well as their routine maintenance. Diagnosing is required to determine root cause of failures in order to effectively perform repairs on cooling systems.

Truck and transport mechanics service, diagnose and repair cooling systems to ensure proper operating temperature of the engine and function of the HVAC system.

#### B-12.01 Services cooling systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
B-12.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-12.01.02P	flush cooling system	cooling system is flushed according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
B-12.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> of cooling system are performed to identify <b>problems</b>
B-12.01.04P	adjust belt tension	belt tension is adjusted according to <b>manufacturers' service information</b>
B-12.01.05P	measure coolant pH, sulphate and chloride levels	coolant pH, sulphate and chloride levels are measured to determine if they meet <b>manufacturers' service information</b> based on type of coolant
B-12.01.06P	test freezing point of coolant	freezing point of coolant is tested using <b>tools and equipment</b>
B-12.01.07P	release <b>stored energy</b>	<b>stored energy</b> is released by allowing system to cool and vent
B-12.01.08P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule

B-12.01.09P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
B-12.01.10P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: refractometers, test strips, hydrometers, vacuum fill kits, flushing equipment

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: smelling leaking coolant, looking for leaks

**problems** include: coolant leaks, low levels, condition of coolant, deterioration and contamination, cracked or missing fan blades, damaged hoses and belts, white exhaust

**stored energy** includes: heat, pressure

**consumables** include: coolant filters, coolant

Knowledge		
	Learning Outcomes	Learning Objectives
B-12.01.01L	demonstrate knowledge of cooling systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of cooling systems, their <b>consumables</b> and <b>components</b> , and describe their characteristics and applications
		describe operating principles of cooling systems and their <b>components</b>
		identify <b>types of coolants</b> and coolant additives, and describe their characteristics and applications
		describe <b>coolant properties</b>
B-12.01.02L	demonstrate knowledge of procedures to service cooling systems, their <b>components</b> and <b>consumables</b>	identify <b>tools and equipment</b> used to service cooling systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to cooling systems and their <b>components</b>
		describe procedures to release <b>stored energy</b>
		describe procedures to inspect cooling systems and their <b>components</b>
		describe procedures to test coolants

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describe procedures to adjust and measure cooling system **components**

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describe procedures to remove, replace, recycle and dispose of cooling system **consumables**

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## Range of Variables

**components** include: oil cooler, thermostats, cooling fan, radiator, hoses, clamps, seals, sealants, gaskets, fans, fan drives, radiator shrouds, belts, radiator caps, recovery tanks, coolant heaters, sensors, mechanical and electric water pumps, controllers

**consumables** include: coolant filters, coolant

**types of coolants** include: conventional, extended life, diesel specific, waterless

**coolant properties** include: pH, freezing point, additive concentrations, conductivity

**tools and equipment** include: refractometers, test strips, hydrometers, vacuum fill kits, flushing equipment

**hazards** include: pressure, steam, extreme heat, moving parts, skin irritation, toxicity

**stored energy** includes: heat, pressure

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## B-12.02 Diagnoses cooling systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
B-12.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
B-12.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-12.02.03P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-12.02.04P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
B-12.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
B-12.02.06P	perform <b>tests</b> to assess <b>system function</b>	<b>tests</b> are performed to assess <b>system function</b> using manufacturer's recommended tools and equipment, and following jurisdictional safety guidelines

B-12.02.07P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
B-12.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure
B-12.02.09P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
B-12.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: coolant loss, low or high operating temperatures, excessive system pressure, warning lights, coolant leaks, no cab heat

**tools and equipment** include: leak testing equipment, pressure measuring devices, refractometers, temperature measuring devices, test strips, fluid analysis sampling kit, hydrometers, belt tension gauges, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: looking for leaks and cracked hoses, smelling for coolant, feeling hoses for damage, checking for contact wear (improper length, routing and securing of hose)

**tests** include: dye, pressure, temperature, fan speed, radiator cap

**system functions** include: correct operation of thermostat, water pump, fan hub and radiator cap

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
B-12.02.01L	demonstrate knowledge of cooling systems, their <b>components</b> , characteristics, applications and operation	identify types of cooling systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of cooling systems and their <b>components</b>
		interpret information pertaining to cooling systems found in <b>manufacturers' service information</b>
		identify <b>types of coolants</b> and coolant additives, and describe their characteristics and applications
B-12.02.02L	demonstrate knowledge of procedures to diagnose cooling systems and their <b>components</b>	describe <b>coolant properties</b>
		identify <b>tools and equipment</b> used to diagnose cooling systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to cooling systems and their <b>components</b>

		describe procedures to release or isolate stored energy
		describe procedures to inspect cooling systems and their <b>components</b>
		describe procedures to test cooling systems and their <b>components</b>
		describe procedures to diagnose cooling systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
B-12.02.03L	demonstrate knowledge of regulatory requirements pertaining to cooling systems and their <b>components</b>	identify and interpret standards and regulations pertaining to cooling systems and their <b>components</b>

## Range of Variables

**components** include: oil cooler, thermostats, cooling fan, radiator, hoses, clamps, seals, sealants, gaskets, fans, fan drives, radiator shrouds, belts, radiator caps, recovery tanks, coolant heaters, sensors, mechanical and electric water pumps, controllers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of coolants** include: conventional, extended life, diesel specific, waterless

**coolant properties** include: pH, freezing point, additive concentrations, conductivity

**tools and equipment** include: leak testing equipment, pressure measuring devices, refractometers, temperature measuring devices, test strips, fluid analysis sampling kit, hydrometers, belt tension gauges, electronic service tools

**hazards** include: pressure, steam, extreme heat, moving parts, skin irritation, toxicity

**symptoms of problems** include: coolant loss, low or high operating temperatures, excessive system pressure, warning lights, coolant leaks, no cab heat

## B-12.03 Repairs cooling systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
B-12.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
B-12.03.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
B-12.03.03P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>

B-12.03.04P	rebuild components	components are rebuilt by replacing parts according to <b>manufacturers' service information</b>
B-12.03.05P	adjust belt tension	belt tension is adjusted according to <b>manufacturers' service information</b> to ensure proper operation of fan and water pump
B-12.03.06P	verify repairs	repairs are verified using <b>methods</b>
B-12.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: torque wrenches, manufacturer-specific tools, lifting devices, flushing equipment, coolant handling equipment, temperature measuring devices, thermostat testing equipment

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: oil cooler, thermostats, cooling fan, radiator, hoses, clamps, seals, sealants, gaskets, fans, fan drives, radiator shrouds, belts, radiator caps, recovery tanks, coolant heaters, sensors, mechanical and electric water pumps, controllers

**methods** include: road testing, pressure testing

Knowledge		
	Learning Outcomes	Learning Objectives
B-12.03.01L	demonstrate knowledge of cooling systems, their <b>components</b> , characteristics, applications and operation	identify types of cooling systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of cooling systems and their <b>components</b>
		identify <b>types of coolants</b> and coolant additives, and describe their characteristics and applications
		describe <b>coolant properties</b>
B-12.03.02L	demonstrate knowledge of procedures to repair cooling systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair cooling systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to cooling systems and their <b>components</b>
		describe procedures to release or isolate stored energy

		describe procedures to remove, replace, adjust, rebuild and repair cooling system <b>components</b>
B-12.03.03L	demonstrate knowledge of regulatory requirements pertaining to cooling systems	identify and interpret standards and regulations to cooling systems

## Range of Variables

**components** include: oil cooler, thermostats, cooling fan, radiator, hoses, clamps, seals, sealants, gaskets, fans, fan drives, radiator shrouds, belts, radiator caps, recovery tanks, coolant heaters, sensors, mechanical and electric water pumps, controllers

**types of coolants** include: conventional, extended life, diesel specific, waterless

**coolant properties** include: pH, freezing point, additive concentrations, conductivity

**tools and equipment** include: torque wrenches, manufacturer-specific tools, lifting devices, flushing equipment, coolant handling equipment, temperature measuring devices, thermostat testing equipment

**hazards** include: pressure, steam, extreme heat, moving parts, skin irritation, toxicity



# Major Work Activity C

## Services, diagnoses and repairs air systems and brake systems

### Task C-13 Services, diagnoses and repairs air systems

#### Task Descriptor

Air systems provide compressed air to control and operate vehicle systems and components such as braking, fan hubs and ride height, and accessories such as seats, wipers and 5<sup>th</sup> wheel slide cylinders. Truck and transport mechanics service, diagnose and repair air systems to ensure proper function and reduce down time.

#### C-13.01 Services air systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
C-13.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
C-13.01.02P	perform sensory inspections	sensory inspections are performed to identify worn, damaged, defective and incorrect <b>components</b>
C-13.01.03P	measure air pressures	air pressures are measured to determine if they meet <b>manufacturers' service information</b> and jurisdictional regulations
C-13.01.04P	release <b>stored energy</b>	<b>stored energy</b> is released by opening air tank drain valves, caging spring brake and fanning down brakes
C-13.01.05P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
C-13.01.06P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations

C-13.01.07P	adjust governing air pressures	governing air pressures are adjusted according to jurisdictional regulations and <b>manufacturers' service information</b>
C-13.01.08P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: air pressure gauges, soap and water, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: air lines, air dryers, governors, compressors, brake chambers (pots), air tanks, valves, low air warning systems

**stored energy** includes: air pressure, spring pressure

**consumables** include: air filters, desiccant

Knowledge		
	Learning Outcomes	Learning Objectives
C-13.01.01L	demonstrate knowledge of air systems, their <b>components</b> and <b>consumables</b> , characteristics, applications and operation	identify types of air systems and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles and design of air systems
C-13.01.02L	demonstrate knowledge of procedures to service air systems and their <b>components</b>	identify <b>tools and equipment</b> used to service air systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to air systems and their <b>components</b>
		describe procedures to release <b>stored energy</b>
		describe procedures to inspect air systems and their <b>components</b>
		describe procedures to service air systems and their <b>components</b>
		describe procedures to remove, replace, recycle and dispose of air system <b>consumables</b>
		identify materials that can be reconditioned, reused or recycled
C-13.01.03L	demonstrate knowledge of regulatory requirements pertaining to air systems	identify and interpret standards and regulations pertaining to air systems

C-13.01.04L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of air system <b>consumables</b>	identify and interpret standards and regulations pertaining to recycling and disposal of air system <b>consumables</b>
C-13.01.05L	demonstrate knowledge of emerging technologies and practices pertaining to air system	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: air lines, air dryers, governors, compressors, brake chambers (pots), air tanks, valves, low air warning systems

**consumables** include: air filters, desiccant

**tools and equipment** include: air pressure gauges, soap and water, electronic service tools

**hazards** include: spring brake, pressurized air

**stored energy** includes: air pressure, spring pressure

## C-13.02 Diagnoses air systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
C-13.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
C-13.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
C-13.02.03P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
C-13.02.04P	perform sensory inspections	sensory inspections of <b>components</b> are performed to confirm complaint and establish preliminary diagnosis
C-13.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
C-13.02.06P	perform <b>tests</b>	<b>tests</b> are performed to assess <b>components</b> for wear, damage and defects by using <b>tools and equipment</b>
C-13.02.07P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis

C-13.02.08P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
C-13.02.09P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: air leaks, slow air pressure build up, system not building pressure

**tools and equipment** include: soap and water, gauges, hand tools, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, logic diagrams

**components** include: brake chambers (pots), air lines, tanks, valves, air gauges, air dryers

**tests** include: pressure tests, timed tests, leak down

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
C-13.02.01L	demonstrate knowledge of air systems, their <b>components</b> , characteristics, applications and operation	identify types of air systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles, design and function of air systems
		interpret information pertaining to air systems found in <b>manufacturers' service information</b>
C-13.02.02L	demonstrate knowledge of procedures to diagnose air systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose air systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to air systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to inspect air systems and their <b>components</b>
		describe procedures to test air systems and their <b>components</b>
		describe procedures to diagnose air systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>

		identify materials that can be reconditioned, reused or recycled
C-13.02.03L	demonstrate knowledge of regulatory requirements pertaining to air systems	identify and interpret standards and regulations pertaining to air systems

## Range of Variables

**components** include: brake chambers (pots), air lines, tanks, valves, air gauges, air dryers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, logic diagrams

**tools and equipment** include: soap and water, gauges, hand tools, electronic service tools

**hazards** include: pressurized air, airborne contaminants, pinch/crush points

**symptoms of problems** include: air leaks, slow air pressure build up, system not building pressure

## C-13.03 Repairs air systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
C-13.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
C-13.03.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
C-13.03.03P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
C-13.03.04P	rebuild <b>components</b>	<b>components</b> are rebuilt by replacing worn parts according to <b>manufacturers' service information</b>
C-13.03.05P	repair <b>components</b>	<b>components</b> are repaired by replacing parts causing failure, according to <b>manufacturers' service information</b>
C-13.03.06P	adjust <b>components</b>	<b>components</b> are adjusted according to <b>manufacturers' service information</b>
C-13.03.07P	disarm and dispose of spring brake chambers	spring brake chambers are disarmed and disposed of according to <b>manufacturers' service information</b> and jurisdictional regulations

C-13.03.08P	verify repairs	repairs are verified using <b>methods</b>
C-13.03.09P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be removed and replaced) include: air lines, relay valves, brake chambers, modulating valves, governors, compressors, air dryer filters

**components** (to be rebuilt) include: air compressors, air dryers, purge valves

**components** (to be repaired) include: air starters, compressors, air dryers, driver warning system, brake chambers

**components** (to be adjusted) include: air governors, ride height valves (levelling valves)

**methods** include: road testing, load testing, sensory observations

Knowledge		
	Learning Outcomes	Learning Objectives
C-13.03.01L	demonstrate knowledge of air systems, their <b>components</b> , characteristics, applications and operation	identify types of air systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles, design and function of air systems
C-13.03.02L	demonstrate knowledge of procedures to repair air systems and their <b>components</b>	identify tools and equipment used to repair air systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to air systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to remove, replace, rebuild, repair and adjust air system <b>components</b>
		identify materials that can be reconditioned, reused or recycled
C-13.03.03L	demonstrate knowledge of regulatory requirements pertaining to air systems	identify and interpret standards and regulations pertaining to air systems

## Range of Variables

**components** include: air lines, relay valves, air compressors, brake chambers, modulating valves, air dryers, filters (air dryer, desiccant), purge valves, air starters, driver warning system, air governors, ride height valves (levelling valves)

**hazards** include: pressurized air, airborne contaminants, pinch/crush points

## Task C-14 Services, diagnoses and repairs brake systems

### Task Descriptor

Brake systems slow, stop or park the vehicle in a safe and controlled manner by using air, hydraulics or cable in conjunction with electronic controls.

Truck and transport mechanics service, diagnose and repair brake systems to ensure proper function and reduce down time.

#### C-14.01 Services brake systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
C-14.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b><i>manufacturers' service information</i></b>
C-14.01.02P	release stored energy in components	stored energy is released in components according to <b><i>manufacturers' service information</i></b>
C-14.01.03P	clean <b><i>components</i></b>	<b><i>components</i></b> are cleaned
C-14.01.04P	perform sensory inspections	sensory inspections are performed to identify leaks and worn, damaged and defective <b><i>components</i></b>
C-14.01.05P	measure <b><i>components</i></b>	<b><i>components</i></b> are measured for brake stroke, out of round, drum or rotor wear and thicknesses to determine if they meet <b><i>manufacturers' service information</i></b> and jurisdictional regulations
C-14.01.06P	check fluid levels in brake reservoir	fluid levels in brake reservoir are checked to determine if they meet <b><i>manufacturers' service information</i></b>
C-14.01.07P	remove and replace <b><i>consumables</i></b>	<b><i>consumables</i></b> are removed and replaced according to <b><i>manufacturers' service information</i></b>
C-14.01.08P	recycle and dispose of <b><i>consumables</i></b>	<b><i>consumables</i></b> are recycled and disposed of according to jurisdictional regulations
C-14.01.09P	adjust brakes and lubricate components	brakes are adjusted and components are lubricated according to <b><i>manufacturers' service information</i></b>
C-14.01.10P	recalibrate ABS components	ABS components are recalibrated according to <b><i>manufacturers' service information</i></b>

C-14.01.11P	bleed hydraulic brakes	hydraulic brakes are bled according to <b>manufacturers' service information</b>
C-14.01.12P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: ABS components, drums, shoes, pads, rotors, cams, slack adjusters, calipers

**components** (to be measured) include: slack adjusters, brake lining, rotors, drums

**consumables** include: brake linings, fluids

Knowledge		
	Learning Outcomes	Learning Objectives
C-14.01.01L	demonstrate knowledge of brake systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of brake systems</b> and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of brake systems and their <b>components</b>
		describe operating principles of ABS and their <b>components</b> , roll stability protection and traction control
		identify <b>air brake components</b> and describe their characteristics and applications
		identify <b>hydraulic brake components</b> and describe their characteristics and applications
		identify <b>emergency (parking) brake components</b> , and describe their characteristics and applications
		identify <b>ABS components</b> and describe their characteristics and applications
		identify types of brake shoes, pads and linings, and describe their characteristics and applications
		identify traction control and braking systems, and describe their characteristics and applications
		identify warning systems and describe their characteristics and applications
		identify types of power-assisted hydraulic brakes and describe their characteristics and applications



C-14.01.02L	demonstrate knowledge of procedures to service brake systems and their <b>components</b>	identify tools and equipment used to service brake systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to brake systems and their <b>components</b>
		describe procedures to release stored energy
		describe procedures to inspect brake systems and their <b>components</b>
		describe procedures to clean, measure, lubricate, adjust and recalibrate brake system <b>components</b>
		describe procedures to remove, replace, recycle and dispose of brake system <b>consumables</b>
		identify materials that can be reconditioned, reused or recycled
C-14.01.03L	demonstrate knowledge of regulatory requirements pertaining to brake systems	identify and interpret standards and regulations pertaining to brake systems
C-14.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to brake systems	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: ABS components, drums, shoes, pads, rotors, cams, slack adjusters, calipers

**consumables** include: brake linings, fluids

**types of brake systems** include: air, hydraulic, emergency (parking) brake, air over hydraulic

**air brake components** include: brake chambers, slack adjusters (automatic and manual), rotors, S-cams, pins, bushings

**hydraulic brake components** include: reservoirs, cylinders, wheel cylinders, brake proportioning valves, brake lines

**emergency (parking) brake components** include: drums, shoes

**ABS components** include: wiring, ECMs, modulating valves and sensors

**hazards** include: pressurized air, oil injection, airborne contaminants, pinch/crush points

## C-14.02 Diagnoses brake systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
C-14.02.01P	identify <b><i>symptoms of problems</i></b>	<b><i>symptoms of problems</i></b> are identified by consulting with customer or operator
C-14.02.02P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
C-14.02.03P	perform <b><i>sensory inspections</i></b>	<b><i>sensory inspections</i></b> are performed to confirm complaint and establish preliminary diagnosis
C-14.02.04P	measure <b><i>components</i></b>	<b><i>components</i></b> are measured for brake stroke, out of round, drum or rotor wear, and thicknesses
C-14.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b><i>manufacturers' service information</i></b> to determine failure
C-14.02.06P	perform <b><i>tests</i></b> to assess components for wear, damage or defects	<b><i>tests</i></b> are performed to assess components for wear, damage or defects using ABS and hydraulic diagnostic equipment
C-14.02.07P	interpret schematics and compare <b><i>test</i></b> results to <b><i>manufacturers' service information</i></b> or expected values	schematics are interpreted and <b><i>test</i></b> results are compared to <b><i>manufacturers' service information</i></b> or expected values to verify diagnosis
C-14.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure
C-14.02.09P	record <b><i>test</i></b> results and inspection findings	<b><i>test</i></b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
C-14.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b><i>next steps</i></b>

## Range of Variables

**symptoms of problems** include: faulty brake operation, air leaks, noises, stopping distance too long, ABS lights on, extended air pressure build time

**tools and equipment** include: digital voltmeter, ABS scan tool, hydraulic diagnostic equipment, electronic service tool, air pressure gauges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: braking performance, ABS lights, oil and air leaks

**components** (to be measured) include: slack adjusters, brake lining and rotors

**tests** include: leak down, performance, road, electronically initiated operational and performance

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
C-14.02.01L	demonstrate knowledge of brake systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of brake systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of brake systems and their <b>components</b>
		interpret information pertaining to brake systems found in <b>manufacturers' service information</b>
C-14.02.02L	demonstrate knowledge of procedures to diagnose brake systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose brake systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to brake systems and their <b>components</b>
		describe procedures to inspect brake systems and their <b>components</b>
		describe procedures to test brake systems and their <b>components</b>
		describe procedures to diagnose brake systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify steps for failure analysis
C-14.02.03L	demonstrate knowledge of regulatory requirements pertaining to brake systems	identify materials that can be reconditioned, reused or recycled
		identify and interpret standards and regulations pertaining to brake systems

## Range of Variables

**components** include: ABS components, drums, shoes, pads, rotors, cams, slack adjusters, calipers

**types of brake systems** include: air, hydraulic, emergency (parking) brake, air over hydraulic, electric

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: digital volt meter, ABS scan tool, hydraulic diagnostic equipment, electronic service tool, air pressure gauges

**hazards** include: pressurized air, oil injection, airborne contaminants, pinch/crush points

**symptoms of problems** include: faulty brake operation, air leaks, noises, stopping distance too long, ABS lights on, extended air pressure build time

### C-14.03 Repairs brake systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
C-14.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
C-14.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
C-14.03.03P	rebuild and repair <b>components</b>	<b>components</b> are rebuilt and repaired according to <b>manufacturers' service information</b>
C-14.03.04P	adjust <b>components</b>	<b>components</b> are adjusted according to <b>manufacturers' service information</b>
C-14.03.05P	verify repairs	repairs are verified using <b>methods</b>
C-14.03.06P	document repairs and verifications	repairs and verifications are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be removed and replaced) include: slack adjusters, brake chambers, cables, wheel cylinders, cylinders

**components** (to be rebuilt and repaired) include: cylinders, calipers, air lines, hydraulic lines, ABS components

**components** (to be adjusted) include: brakes, ABS sensors, parking brakes

**methods** include: road testing, load testing, sensory observations

Knowledge		
	Learning Outcomes	Learning Objectives
C-14.03.01L	demonstrate knowledge of brake systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of brake systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of brake systems and their <b>components</b>
C-14.03.02L	demonstrate knowledge of procedures to repair brake systems and their <b>components</b>	identify tools and equipment used to repair brake systems and their <b>components</b> , and describe their applications and procedures for use
		describe procedures to remove, replace, rebuild, adjust and repair brake system <b>components</b>
		identify <b>hazards</b> and describe safe work practices pertaining to brake systems and their <b>components</b>
		describe <b>methods</b> used to verify repairs
		identify materials that can be reconditioned, reused or recycled
C-14.03.03L	demonstrate knowledge of regulatory requirements pertaining to brake systems	identify and interpret standards and regulations pertaining to brake systems
		identify jurisdictional requirements for road testing and road worthiness
C-14.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to brake systems	identify technologies that address emissions and pollution, and describe their characteristics and applications

### Range of Variables

**components** include: ABS components, drums, shoes, pads, rotors, cams, slack adjusters, calipers

**types of brake systems** include: air, hydraulic, emergency (parking) brake, air over hydraulic

**hazards** include: pressurized air, spring pressure, oil injection, airborne contaminants, pinch/crush points

**methods** include: road testing, load testing, sensory observations

# Major Work Activity D

## Services, diagnoses and repairs electrical and electronic systems

### Task D-15 Services, diagnoses and repairs battery systems

#### Task Descriptor

Truck and transport mechanics need to understand low-voltage battery systems, their applications and limitations in order to service, diagnose and repair them safely. Safety is an important consideration when working with battery systems.

#### D-15.01 Services battery systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
D-15.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-15.01.02P	clean battery <b>components</b>	battery <b>components</b> are cleaned
D-15.01.03P	perform sensory inspection	sensory inspection of battery system is performed to identify <b>defects</b>
D-15.01.04P	test batteries	batteries are tested to confirm they maintain charge
D-15.01.05P	measure specific gravity of each cell	specific gravity of each cell is measured
D-15.01.06P	compare test results to manufacturers' specifications and standards or expected values	test results are compared to <b>manufacturers' service information</b> or expected values
D-15.01.07P	replace faulty and damaged batteries	faulty and damaged batteries are replaced
D-15.01.08P	adjust electrolyte levels	electrolyte levels are adjusted
D-15.01.09P	recharge batteries	batteries are recharged according to <b>manufacturers' service information</b>
D-15.01.10P	disconnect and connect batteries in sequence	batteries are disconnected and connected in sequence according to <b>manufacturers' service information</b>

D-15.01.11P	apply anti-corrosion compounds to terminals and connections	anti-corrosion compounds are applied to terminals and connections according to <b>manufacturers' service information</b>
D-15.01.12P	recycle and dispose of batteries	batteries are recycled and disposed of according to jurisdictional regulations
D-15.01.13P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: hand tools, specialized testing equipment, multimeters, carbon pile, inductance testers, hydrometers, refractometers, electronic service tools

**manufacturers' service information** include: specifications, standards, procedures

**components** include: terminals, connections, casing, compartment

**defects** include: corroded and loose terminals, missing caps, damaged casing, loose and missing battery securement (hold-downs), low electrolyte

Knowledge		
	Learning Outcomes	Learning Objectives
D-15.01.01L	demonstrate knowledge of battery systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of battery systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of battery systems and their <b>components</b>
		identify <b>types of batteries</b> and their <b>components</b> , and describe their characteristics and applications
		identify <b>battery ratings</b>
		describe battery maintenance schedules
D-15.01.02L	demonstrate knowledge of procedures to service battery systems and their <b>components</b>	identify <b>tools and equipment</b> used to service battery systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to battery systems and their <b>components</b>
		describe procedures to inspect battery systems and their <b>components</b>
		describe procedures to test battery systems and their <b>components</b>
		describe procedures to service battery systems and their <b>components</b>
		describe procedures to remove, replace, recharge, recycle and dispose of batteries
		identify materials that can be reconditioned, reused or recycled

		identify practices that reduce material waste
D-15.01.03L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of batteries	identify and interpret standards and regulations pertaining to recycling and disposal of batteries
D-15.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to battery systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: terminals, connections, casing, compartment

**types of battery systems** include: parallel, series, series/parallel

**types of batteries** include: sealed, vented, absorbed glass mat (AGM), gel cell, lithium, capacitor

**battery ratings** include: cranking amps (CA), cold cranking amps (CCA), reserve capacity (RC), amp hour, voltages

**tools and equipment** include: hand tools, specialized testing equipment, multimeters, carbon pile, inductance testers, hydrometers, refractometers, electronic service tools

**hazards** include: shocks, sparks, explosive gases, acid spillage, acid burns, electrical burns, heavy weight, lead exposure

## D-15.02 Diagnoses battery systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
D-15.02.01P	identify <b><i>symptoms of problems</i></b>	<b><i>symptoms of problems</i></b> are identified by consulting with customer or operator
D-15.02.02P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
D-15.02.03P	perform sensory inspection	sensory inspection of battery system is performed to identify <b><i>defects</i></b>
D-15.02.04P	test batteries	batteries are tested to assess condition and capacity
D-15.02.05P	measure specific gravity	specific gravity is measured to assess condition of each cell for lack of clarity due to sulfating and for correct electrolyte value according to <b><i>manufacturers' service information</i></b>



D-15.02.06P	perform voltage drop on cable systems	voltage drop on cable systems is performed according to <b>manufacturers' service information</b>
D-15.02.07P	compare test results to <b>manufacturers' service information</b> or expected values	test results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
D-15.02.08P	perform failure analysis	failure analysis is performed to determine root cause of <b>failure</b>
D-15.02.09P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: no start, hard start, battery smells, battery compartment smoking, noises, charging issues

**tools and equipment** include: hand tools, specialized testing equipment, multimeters, carbon pile, inductance testers, hydrometers, refractometers, electronic service tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**defects** include: corroded and loose terminals, missing caps, casing damage, loose and missing battery securement (hold-downs), low electrolyte

**failures** include: parasitic amperage draw, overcharging, undercharging, loose connections, corroded connections, frozen battery, low open circuit voltage

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
D-15.02.01L	demonstrate knowledge of battery systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of battery systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of battery systems and their <b>components</b>
		identify <b>types of batteries</b> and their <b>components</b> , and describe their characteristics and applications
		identify <b>battery ratings</b>
		describe battery maintenance schedules
D-15.02.02L	demonstrate knowledge of procedures to diagnose battery systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose battery systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to battery systems and their <b>components</b>
		describe procedures to inspect battery systems and their <b>components</b>
		describe procedures to test battery systems and their <b>components</b>

		describe procedures to diagnose battery systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify <b>defects</b> and <b>failures</b> found in battery systems
		identify procedures and safe work practices to boost vehicles
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-15.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to battery systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: terminals, connections, casing, compartment

**types of battery systems** include: parallel, series, series/parallel,

**types of batteries** include: sealed, vented, AGM, gel cell, lithium, capacitor

**battery ratings** include: CA, CCA, RC, amp-hour

**tools and equipment** include: hand tools, specialized testing equipment, multimeters, carbon pile, inductance testers, hydrometers, refractometers, electronic service tools

**hazards** include: shocks, sparks, explosive gases, acid spillage, acid burns, electrical burns, heavy weight, lead exposure

**symptoms of problems** include: no start, hard start, battery smells, battery compartment smoking, noises, charging issues

**defects** include: corroded and loose terminals, missing caps, casing damage, loose and missing battery securement (hold-downs), low electrolyte

**failures** include: parasitic amperage draw, overcharging, undercharging, loose connections, corroded connections, frozen battery, low open circuit voltage

## D-15.03 Repairs battery systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
D-15.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-15.03.02P	clean battery <b>components</b>	battery <b>components</b> are cleaned
D-15.03.03P	disconnect and connect batteries in sequence	batteries are disconnected and connected in sequence according to <b>manufacturers' service information</b>
D-15.03.04P	replace faulty and damaged batteries	faulty and damaged batteries are replaced
D-15.03.05P	apply anti-corrosion compounds to terminals and connections	anti-corrosion compounds are applied to terminals and connections according to <b>manufacturers' service information</b>
D-15.03.06P	replace and repair connecting cables	connecting cables are replaced and repaired according to <b>manufacturers' service information</b>
D-15.03.07P	check battery hold-downs and compartment	battery hold-downs and compartment are checked to ensure they are secure and in good condition
D-15.03.08P	recharge batteries	batteries are recharged according to <b>manufacturers' service information</b>
D-15.03.09P	recycle or dispose of batteries	batteries are recycled or disposed of according to jurisdictional regulations
D-15.03.10P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: hand tools, lifting equipment, electronic service tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** include: terminals, connections, compartment

### Knowledge

	Learning Outcomes	Learning Objectives
D-15.03.01L	demonstrate knowledge of battery systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of battery systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of battery systems and their <b>components</b>

		identify <b>types of batteries</b> and their <b>components</b> , and describe their characteristics and applications
		identify <b>battery ratings</b>
D-15.03.02L	demonstrate knowledge of procedures to repair battery systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair battery systems and their <b>components</b> , and describe their applications and procedures for use
		describe procedures to repair battery systems and their <b>components</b>
		describe procedures to remove, replace, recharge, recycle and dispose of batteries
		identify <b>hazards</b> and describe safe work practices pertaining to battery systems and their <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-15.03.03L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of batteries	identify and interpret standards and regulations pertaining to recycling and disposal of batteries
D-15.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to battery systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: terminals, connections, compartment

**types of battery systems** include: parallel, series, series/parallel

**types of batteries** include: sealed, vented, AGM, gel cell, lithium, capacitor

**battery ratings** include: CA, CCA, RC, amp-hour

**tools and equipment** include: hand tools, lifting equipment, electronic service tools

**hazards** include: shocks, sparks, explosive gases, acid spillage, acid burns, electrical burns, heavy weight, lead exposure

## Task D-16 Services, diagnoses and repairs charging systems

### Task Descriptor

Truck and transport mechanics must have a good understanding of the different vehicle charging systems, their operation and components.

#### D-16.01 Services charging systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
D-16.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-16.01.02P	clean terminals and connections of components	terminals and connections of components are cleaned according to <b>manufacturers' service information</b>
D-16.01.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
D-16.01.04P	adjust voltage regulator and belt tension	voltage regulator and belt tension are adjusted according to <b>manufacturers' service information</b>
D-16.01.05P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**tools and equipment** include: hand tools, belt tension gauges, torque wrenches, carbon pile testers, multimeters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: alternators, internal and external regulators, diodes, wiring, relays, belts, cooling fins, ECMs, mounting hardware

Knowledge		
	Learning Outcomes	Learning Objectives
D-16.01.01L	demonstrate knowledge of charging systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of charging systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of charging systems and their <b>components</b>
		describe basic principles of electricity and circuit components
		identify <b>types of alternators</b> and their components, and describe their ratings, characteristics, applications and operation
D-16.01.02L	demonstrate knowledge of procedures to service charging systems and their <b>components</b>	identify <b>tools and equipment</b> used to service charging systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to charging systems and their <b>components</b>
		describe procedures to inspect charging systems and their <b>components</b>
		describe procedures to clean and adjust charging system <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-16.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to charging systems	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: alternators, internal and external regulators, diodes, wiring, relays, belts, cooling fins, ECMs, mounting hardware

**types of charging systems** include: A or B regulator, 12-volt and 24-volt batteries, externally or internally regulated, solid-state chargers

**types of alternators** include: air/oil cooled, belt-driven, gear-driven

**tools and equipment** include: hand tools, belt tension gauges, torque wrenches, carbon pile testers, multimeters

**hazards** include: sparks, moving components, burns, shocks, battery explosions, noises

## D-16.02 Diagnoses charging systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
D-16.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
D-16.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-16.02.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b> to confirm complaint and establish preliminary diagnosis
D-16.02.04P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>
D-16.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
D-16.02.06P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
D-16.02.07P	perform failure analysis	failure analysis is performed to determine root cause of failure
D-16.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

### Range of Variables

**symptoms of problems** include: overcharging, undercharging, warning lights, smells, failed lights, components not working, dead battery, noises

**tools and equipment** include: hand tools, belt tension gauges, torque wrenches, carbon pile testers, multimeters, inductance testers, electronic service tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards  
**components** include: alternators, internal and external regulators, diodes, wiring, relays, belts, cooling fins, ECMs, mounting hardware

**tests** include: full fielding alternator, voltage drop of cables, alternator output, checking fault codes

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
Learning Outcomes		Learning Objectives
D-16.02.01L	demonstrate knowledge of charging systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of charging systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of charging systems and their <b>components</b>
		describe basic principles of electricity and circuit components
		identify <b>types of alternators</b> and their components, and describe their ratings, characteristics, applications and operation
D-16.02.02L	demonstrate knowledge of procedures to diagnose charging systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose charging systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to charging systems and their <b>components</b>
		describe procedures to inspect charging systems and their <b>components</b>
		describe procedures to test charging systems and their <b>components</b>
		describe procedures to diagnose charging systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify common faults found when diagnosing charging systems
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-16.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to charging systems	identify technologies that address emissions and pollution, and describe their characteristics and applications



## Range of Variables

**components** include: alternators, internal and external regulators, diodes, wiring, relays, belts, cooling fins, ECMs, mounting hardware

**types of charging systems** include: A or B regulator, 12-volt and 24-volt batteries, externally or internally regulated, solid-state chargers

**types of alternators** include: air/oil cooled, belt-driven, gear-driven

**tools and equipment** include: hand tools, belt tension gauges, torque wrenches, carbon pile testers, multimeters, inductance testers, electronic service tools

**hazards** include: sparks, moving components, burns, shocks, battery explosions, noises

**symptoms of problems** include: overcharging, undercharging, warning lights, smells, failed lights, components not working, dead battery, noises

### D-16.03 Repairs charging systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
D-16.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-16.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
D-16.03.03P	adjust belt tension	belt tension is adjusted according to <b>manufacturers' service information</b>
D-16.03.04P	construct and repair cables	cables are constructed and repaired by crimping and soldering connectors and terminals
D-16.03.05P	rebuild, repair or replace alternator	alternator is rebuilt or repaired by testing and replacing failed components, or replaced according to <b>manufacturers' service information</b>
D-16.03.06P	verify repairs	repairs are verified using <b>methods</b>
D-16.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: hand tools, belt tension gauges, torque wrenches, carbon pile testers, multimeters, inductance testers, cable crimpers, soldering tools, electronic service tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** include: alternators, internal and external regulators, diodes, wiring, relays, belts, cooling fins, ECMs, mounting hardware

**methods** include: full fielding, bench testing, on-vehicle testing, checking fault codes

Knowledge		
	Learning Outcomes	Learning Objectives
D-16.03.01L	demonstrate knowledge of charging systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of charging systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of charging systems and their <b>components</b>
		describe basic principles of electricity and circuit components
		identify <b>types of alternators</b> and their components, and describe their ratings, characteristics, applications and operation
D-16.03.02L	demonstrate knowledge of procedures to repair charging systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair charging systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to charging systems and their <b>components</b>
		describe procedures to remove, replace, adjust, rebuild and repair charging systems and their <b>components</b>
		describe procedures to excite alternators
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-16.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to charging systems	identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to testing charging systems

## Range of Variables

**components** include: alternators, internal and external regulators, diodes, wiring, relays, belts, cooling fins, ECMs, mounting hardware

**types of charging systems** include: A or B regulator, 12-volt and 24-volt batteries, externally or internally regulated, solid-state chargers

**types of alternators** include: air/oil cooled, belt-driven, gear-driven

**tools and equipment** include: hand tools, belt tension gauges, torque wrenches, carbon pile testers, multimeters, inductance testers, cable crimpers, soldering tools, electronic service tools

**hazards** include: sparks, moving components, burns, shocks, battery explosions, noises

## Task D-17 Services, diagnoses and repairs spark ignition systems

### Task Descriptor

Spark ignition systems are being reintroduced into the truck and transport industry through alternate fuel sources that reduce greenhouse gas emissions and costs. Although there have been some changes due to technological advances, the basic principles are still applicable today.

Truck and transport mechanics service, diagnose and repair spark ignition systems to ensure proper function and reduce down time.

#### D-17.01 Services spark ignition systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
D-17.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-17.01.02P	perform sensory inspections	sensory inspections are performed to identify <b>defects</b>
D-17.01.03P	replace <b>components</b>	<b>components</b> are replaced according to <b>manufacturers' service information</b>
D-17.01.04P	adjust spark plug gap	spark plug gap is adjusted according to <b>manufacturers' service information</b>
D-17.01.05P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: scan tools, electronic service tools, oscilloscopes, spark testers, spark plug gapping tools, feeler gauges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**defects** include: damaged wires, coil terminals and spark plugs

**components** include: spark plugs, coils, high-tension wires, ECMs

Knowledge		
	Learning Outcomes	Learning Objectives
D-17.01.01L	demonstrate knowledge of spark ignition systems, their <b>components</b> , characteristics, applications and operation	identify types of spark ignition systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of spark ignition systems and their <b>components</b>
		describe electrical fundamentals
		describe <b>engine operating principles</b>
D-17.01.02L	demonstrate knowledge of procedures to service spark ignition systems and their <b>components</b>	identify <b>tools and equipment</b> used to service spark ignition systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to spark ignition systems and their <b>components</b>
		describe procedures to inspect spark ignition systems and their <b>components</b>
		describe procedures to measure, adjust and replace spark ignition system <b>components</b>
		identify materials that can be reconditioned, reused or recycled
D-17.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to spark ignition systems	identify practices that reduce material waste
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: spark plugs, coils, high-tension wires, ECMs

**engine operating principles** include: firing order, ignition timing, combustion cycle

**tools and equipment** include: scan tools, electronic service tools, oscilloscopes, spark testers, spark plug gapping tools, feeler gauges

**hazards** include: shocks, sparks, moving components, burns, noises

## D-17.02 Diagnoses spark ignition systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
D-17.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
D-17.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-17.02.03P	perform sensory inspections	sensory inspections are performed to identify <b>defects</b>
D-17.02.04P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>
D-17.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
D-17.02.06P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
D-17.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

### Range of Variables

**symptoms of problems** include: intermittent problems, no start, hard starting, misfiring, fuel economy issues

**tools and equipment** include: scan tools, electronic service tools, oscilloscopes, spark testers, spark plug gaping tools, feeler gauges, multimeters

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**defects** include: damaged wires, coil terminals, spark plugs, distributor caps and rotors

**tests** include: measure coil resistance in primary and secondary circuits, spark testing, high tension leads

**next steps** include: repairs, component replacement or adjustment, further diagnosis

### Knowledge

	Learning Outcomes	Learning Objectives
D-17.02.01L	demonstrate knowledge of spark ignition systems, their <b>components</b> , characteristics, applications and operation	identify types of spark ignition systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of spark ignition systems and their <b>components</b>
		describe electrical fundamentals
		describe <b>engine operating principles</b>

D-17.02.02L	demonstrate knowledge of procedures to diagnose spark ignition systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose spark ignition systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to spark ignition systems and their <b>components</b>
		describe procedures to inspect spark ignition systems and their <b>components</b>
		describe procedures to test spark ignition systems and their <b>components</b>
		describe procedures to diagnose spark ignition systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify <b>common faults</b> found in spark ignition systems
		identify materials that can be reconditioned, reused or recycled
D-17.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to spark ignition systems	identify practices that reduce material waste
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: spark plugs, coils, high-tension wires, modules, distributor caps and rotors

**engine operating principles** include: firing order, ignition timing, combustion cycle

**tools and equipment** include: scan tools, electronic service tools, oscilloscopes, spark testers, spark plug gapping tools, feeler gauges, multimeters

**hazards** include: shocks, sparks, moving components, burns, noises

**symptoms of problems** include: intermittent problems, no start, hard starting, misfiring, fuel economy issues

**common faults** include: faulty wiring, low voltage, faulty ECMs, poor grounds, faulty spark plugs, faulty coils, faulty high-tension wires, faulty distributor caps and rotors

## D-17.03 Repairs spark ignition systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
D-17.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-17.03.02P	perform sensory inspections	sensory inspections are performed to identify <b>defects</b>
D-17.03.03P	replace and repair <b>components</b>	<b>components</b> are replaced and repaired according to <b>manufacturers' service information</b>
D-17.03.04P	adjust spark plug gap	spark plug gap is adjusted according to <b>manufacturers' service information</b>
D-17.03.05P	verify repairs	repairs are verified using <b>methods</b> while running engine at operating condition
D-17.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: scan tools, electronic service tools, oscilloscopes, spark testers, spark plug gapping tools, feeler gauges, multimeters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**defects** include: damaged wires, coil terminals, spark plugs, distributor caps and rotors

**components** include: plugs, coils, high-tension wires, wiring, modules, distributor caps and rotors

**methods** include: road testing, checking fault codes, re-testing oscilloscope readings

### Knowledge

	Learning Outcomes	Learning Objectives
D-17.03.01L	demonstrate knowledge of spark ignition systems, their <b>components</b> , characteristics, applications and operation	identify types of spark ignition systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of spark ignition systems and their <b>components</b>
		describe electrical fundamentals
		describe <b>engine operating principles</b>
D-17.03.02L	demonstrate knowledge of procedures to repair spark ignition systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair spark ignition systems and their <b>components</b> , and describe their applications and procedures for use

		identify <b>hazards</b> and describe safe work practices pertaining to spark ignition systems and their <b>components</b>
		describe procedures to inspect spark ignition systems and their <b>components</b>
		describe procedures to measure, adjust, replace and repair spark ignition system <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-17.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to spark ignition systems	identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: plugs, coils, high-tension wires, wiring, modules, distributor caps and rotors

**engine operating principles** include: firing order, ignition timing, combustion cycle

**tools and equipment** include: scan tools, electronic service tools, oscilloscopes, spark testers, spark plug gapping tools, feeler gauges, multimeters

**hazards** include: shocks, sparks, moving components, burns, noises



## Task D-18 Services, diagnoses and repairs starting systems

### Task Descriptor

Truck and transport mechanics must have a good understanding of starting systems, their operation and components in order to safely service, diagnose and repair them.

#### D-18.01 Services starting systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
D-18.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-18.01.02P	perform sensory inspections	sensory inspections are performed to identify <b>defects</b>
D-18.01.03P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
D-18.01.04P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>

### Range of Variables

**tools and equipment** include: hand tools, carbon pile testers, multimeters, electronic service tools, test lights

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**defects** include: loose, worn and corroded cables; loose starter mountings; loose and corroded magnetic switch connections; arcing connections

**components** (to be cleaned) include: connections, terminals

**tests** include: starter amp draw, voltage drop cables, neutral safety system

#### Knowledge

	Learning Outcomes	Learning Objectives
D-18.01.01L	demonstrate knowledge of starting systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of starting systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of starting systems and their <b>components</b>
		interpret information pertaining to starting systems found in <b>manufacturers' service information</b>

		describe safety interlock devices designed to prevent starting of vehicle in an unsafe condition
		describe basic principles of electricity and circuit components
D-18.01.02L	demonstrate knowledge of procedures to service starting systems and their <b>components</b>	identify <b>tools and equipment</b> used to service starting systems and their <b>components</b> , and describe their applications and procedures for use
		describe procedures to service starting systems and their <b>components</b>
		describe procedures to inspect starting systems and their <b>components</b>
		identify <b>hazards</b> and describe safe work practices pertaining to starting systems and their <b>components</b>
		identify <b>defects</b> found in starting systems
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-18.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to starting systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: starters, ECMs, solenoids, relays, cables, connections, terminals, ignition switches, wiring

**types of starting systems** include: 12-volt, 24-volt

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: hand tools, carbon pile testers, multimeters, electronic service tools, test lights

**hazards** include: shocks, sparks, moving components, burns, noises, lead and toxic metal exposure

**defects** include: loose, worn and corroded cables; loose starter mountings; loose and corroded magnetic switch connections; arcing connections

## D-18.02 Diagnoses starting systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
D-18.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
D-18.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-18.02.03P	perform sensory inspections	sensory inspections are performed to identify <b>defects</b>
D-18.02.04P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>
D-18.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
D-18.02.06P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
D-18.02.07P	perform failure analysis	failure analysis is performed to determine root cause of failure
D-18.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

### Range of Variables

**symptoms of problems** include: no, slow or constant cranking; intermittent operation; noisy starter operation

**tools and equipment** include: hand tools, carbon pile testers, multimeters, electronic service tools, test lights

**manufacturers' service information** include: specifications, recommendations, procedures, standards, logic diagrams

**defects** include: loose, worn and corroded cables; loose starter mountings; loose and corroded magnetic switch connections; arcing connections

**tests** include: starter draw, voltage drop, fault codes

**next steps** include: repairs, component replacement or adjustment, further diagnosis

## Knowledge

Learning Outcomes		Learning Objectives
D-18.02.01L	demonstrate knowledge of starting systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of starting systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of starting systems and their <b>components</b>
		describe basic principles of electricity and circuit components
		interpret information pertaining to starting systems found in <b>manufacturers' service information</b>
D-18.02.02L	demonstrate knowledge of procedures to diagnose starting systems and their <b>components</b>	describe safety interlock devices designed to prevent starting of vehicle in an unsafe condition
		identify <b>tools and equipment</b> used to diagnose starting systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to starting systems and their <b>components</b>
		describe procedures to inspect starting systems and their <b>components</b>
		describe procedures to test starting systems and their <b>components</b>
		describe procedures to diagnose starting systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		describe <b>common faults</b> found while inspecting starting systems and their <b>components</b>
D-18.02.03L	demonstrate knowledge of regulatory requirements pertaining to neutral safety systems	identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
		identify and interpret standards and jurisdictional regulations pertaining to neutral safety systems

D-18.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to starting systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: starters, modules, solenoids, relays, cables, connections, terminals, ignition switches, wiring

**types of starting systems** include: 12-volt, 24-volt

**manufacturers' service information** include: specifications, recommendations, procedures, standards, logic diagrams

**tools and equipment** include: hand tools, carbon pile testers, multimeters, electronic service tools, test lights

**hazards** include: shocks, sparks, moving components, burns, noises, lead and toxic metal exposure

**symptoms of problems** include: no, slow or constant cranking; intermittent operation; noisy starter operation

**common faults** include: dead battery, frayed cables, high resistance in cables and connections, excess starter draw, burnt and corroded solenoid contacts

## D-18.03 Repairs starting systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
D-18.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-18.03.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
D-18.03.03P	remove and replace starter	starter is removed and replaced according to <b>manufacturers' service information</b>
D-18.03.04P	replace <b>components</b>	<b>components</b> are replaced according to <b>manufacturers' service information</b>
D-18.03.05P	rebuild starter	starter is rebuilt using <b>methods</b> according to <b>manufacturers' service information</b>

D-18.03.06P	verify repairs	repairs are verified using <b>methods</b>
D-18.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: carbon pile testers, multimeters, electronic service tools, test lights, armature growlers

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** (to be cleaned) include: connections, terminals

**components** (to be replaced) include: solenoids, relays, cables, connections, ignition switches, modules, interlock switches

**methods** (to rebuild starter) include: replacing solenoid, brushes, bushings and starter drives; testing armatures and field windings; setting starter drive air gap

**methods** (to verify repairs) include: testing bench and starter draw, verifying fault codes

Knowledge		
	Learning Outcomes	Learning Objectives
D-18.03.01L	demonstrate knowledge of starting systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of starting systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of starting systems and their <b>components</b>
		interpret information pertaining to starting systems found in <b>manufacturers' service information</b>
		describe basic principles of electricity and circuit components
D-18.03.02L	demonstrate knowledge of procedures to repair starting systems and their <b>components</b>	describe safety interlock devices designed to prevent starting of vehicle in an unsafe condition
		identify <b>tools and equipment</b> used to repair starting systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to starting systems and their <b>components</b>
		describe procedures to replace, clean and repair starting system <b>components</b>
		describe procedures to rebuild starters
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste

D-18.03.03L	demonstrate knowledge of regulatory requirements pertaining to neutral safety systems	identify and interpret standards and jurisdictional regulations pertaining to neutral safety systems
D-18.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to starting systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: connections, terminals, solenoids, relays, cables, ignition switches, modules, interlock switches

**types of starting systems** include: 12-volt, 24-volt

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**tools and equipment** include: carbon pile testers, multimeters, electronic service tools, test lights, armature growlers

**hazards** include: shocks, sparks, moving components, burns, noises, lead and toxic metal exposure, heavy components

## Task D-19 Services, diagnoses and repairs electrical components and accessories

### Task Descriptor

Truck and transport mechanics must be able to service, diagnose and repair electrical system faults using multimeters and specialized tools in order to return the vehicle to service. They must have a good understanding of the basic principles of electricity and circuitry.

#### D-19.01 Services electrical components and accessories

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
D-19.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-19.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
D-19.01.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b> and connections
D-19.01.04P	identify <b>high-voltage electrical systems</b> requiring specialized training and safety precautions	<b>high-voltage electrical systems</b> requiring specialized training and safety precautions are identified
D-19.01.05P	identify and tighten loose connections	loose connections are identified and tightened according to <b>manufacturers' service information</b>
D-19.01.06P	apply anti-corrosion compound	anti-corrosion compound is applied according to <b>manufacturers' service information</b>
D-19.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking



## Range of Variables

**tools and equipment** include: hand tools, multimeters, test lights, terminal cleaning tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** (to be cleaned) include: corroded terminals, sockets, junction boxes

**components** include: terminals, sockets, junction boxes, light bulbs, fuses, harnesses, plug-in connectors, wiring, resistors, relays, switches, diodes, breakers

**high-voltage electrical systems** include: hybrid, EV, lighting (fluorescents, dash lights)

Knowledge		
	Learning Outcomes	Learning Objectives
D-19.01.01L	demonstrate knowledge of electrical <b>components</b> and <b>accessories</b> , their characteristics, applications and operation	identify types of electrical <b>components</b> and <b>accessories</b> , and describe their characteristics and applications
		describe operating principles of electricity and electrical <b>components</b> and <b>accessories</b>
		interpret wiring schematics and logic diagrams
		identify systems with stored energy sources
D-19.01.02L	demonstrate knowledge of <b>high-voltage electrical systems</b> , their characteristics, applications and operation	identify <b>hazards</b> and describe safe work practices pertaining to <b>high-voltage electrical systems</b> and their <b>components</b> and <b>accessories</b>
D-19.01.03L	demonstrate knowledge of procedures to service electrical <b>components</b> and <b>accessories</b>	identify <b>tools and equipment</b> used to service electrical <b>components</b> and <b>accessories</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to electrical <b>components</b> and <b>accessories</b>
		describe procedures to inspect electrical <b>components</b> and <b>accessories</b>
		describe procedures to clean electrical <b>components</b> and <b>accessories</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste

D-19.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to electrical <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: terminals, sockets, junction boxes, light bulbs, fuses, harnesses, plug-in connectors, wiring, resistors, relays, switches, diodes, breakers

**accessories** include: driving lights, rotary beacons, block heaters, auxiliary power units, seat heaters

**high-voltage electrical systems** include: hybrid, EV, lighting (fluorescents, dash lights)

**hazards** include: electrocution, shocks, sparks, moving parts

**tools and equipment** include: hand tools, multimeters, test lights, terminal cleaning tools

## D-19.02 Diagnoses electrical components and accessories

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
D-19.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
D-19.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-19.02.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b> and connections
D-19.02.04P	identify <b>high-voltage electrical systems</b> requiring specialized training and safety precautions	<b>high-voltage electrical systems</b> requiring specialized training and safety precautions are identified
D-19.02.05P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>
D-19.02.06P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
D-19.02.07P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis

D-19.02.08P	perform failure analysis	failure analysis is performed on <b>components</b> and <b>accessories</b> to determine root cause of failure
D-19.02.09P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to <b>manufacturers' service information</b>
D-19.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: blown fuses, dim or bright lighting, components not operating, noises, smells, smoke, hot components

**tools and equipment** include: multimeters, test lights, hand tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards, service bulletins, logic diagrams

**components** include: terminals, sockets, junction boxes, light bulbs, fuses, harnesses, plug-in connectors, wiring, resistors, relays, switches, diodes, breakers

**high-voltage electrical systems** include: hybrid, EV, lighting (fluorescents, dash lights)

**tests** include: measuring voltage, amperage and resistance values in electrical circuits

**accessories** include: driving lights, rotary beacons, block heaters, auxiliary power units, seat heaters

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
D-19.02.01L	demonstrate knowledge of electrical <b>components</b> and <b>accessories</b> , their characteristics, applications and operation	identify types of electrical <b>components</b> and <b>accessories</b> , and describe their characteristics and applications
		describe operating principles of electricity and electrical <b>components</b> and <b>accessories</b>
		interpret wiring schematics and logic diagrams
		identify systems with stored energy sources
D-19.02.02L	demonstrate knowledge of <b>high-voltage electrical systems</b> , their characteristics, applications and operation	identify hazards and describe safe work practices pertaining to <b>high-voltage electrical systems</b>
D-19.02.03L	demonstrate knowledge of procedures to diagnose electrical <b>components</b> and <b>accessories</b>	identify <b>tools and equipment</b> used to diagnose electrical <b>components</b> and <b>accessories</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to electrical <b>components</b> and <b>accessories</b>
		describe procedures to inspect electrical <b>components</b> and <b>accessories</b>

		describe procedures to test electrical <b>components</b> and <b>accessories</b>
		describe procedures to diagnose electrical <b>components</b> and <b>accessories</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-19.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to electrical <b>components</b> and <b>accessories</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: terminals, sockets, junction boxes, light bulbs, fuses, harnesses, plug-in connectors, wiring, resistors, relays, switches, diodes, breakers

**accessories** include: driving lights, rotary beacons, block heaters, auxiliary power units, seat heaters

**high-voltage electrical systems** include: hybrid, EV, lighting (fluorescents, dash lights)

**tools and equipment** include: multimeters, test lights, hand tools

**hazards** include: electrocution, shocks, sparks, moving parts

**symptoms of problems** include: blown fuses, dim or bright lighting, components not operating, noises, smells, smoke, hot components

## D-19.03 Repairs electrical components and accessories

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
D-19.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-19.03.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
D-19.03.03P	identify <b>high-voltage electrical systems</b> requiring specialized training and safety precautions	<b>high-voltage electrical systems</b> requiring specialized training and safety precautions are identified

D-19.03.04P	replace <b>components</b> and <b>accessories</b>	<b>components</b> and <b>accessories</b> are replaced according to <b>manufacturers' service information</b>
D-19.03.05P	repair <b>components</b>	<b>components</b> are repaired according to <b>manufacturers' service information</b>
D-19.03.06P	identify and tighten loose connections	loose connections are identified and tightened according to <b>manufacturers' service information</b>
D-19.03.07P	apply anti-corrosion compound	anti-corrosion compound is applied according to <b>manufacturers' service information</b>
D-19.03.08P	select and match <b>components</b> to electrical load	<b>components</b> are selected and matched to electrical load according to <b>manufacturers' service information</b>
D-19.03.09P	install optional <b>accessories</b>	optional <b>accessories</b> are installed according to <b>manufacturers' service information</b>
D-19.03.10P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
D-19.03.11P	verify repairs	repairs are verified under normal operating conditions to ensure it is within <b>manufacturers' service information</b>
D-19.03.12P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: multimeters, test lights, hand tools, terminal and connector repair tools  
**manufacturers' service information** include: specifications, recommendations, procedures, standards, service bulletins

**components** (to be cleaned) include: corroded terminals, sockets, junction boxes

**high-voltage electrical systems** include: hybrid, EV, lighting (fluorescents, dash lights)

**components** (to be replaced) include: light bulbs, fuses, harnesses, plug-in connectors, switches, relays, breakers

**accessories** include: driving lights, rotary beacons, block heaters, auxiliary power units, seat heaters

**components** (to be repaired) include: faulty wiring, corroded terminals, sockets and connectors

**components** (to be matched to electrical load) include: wiring, resistors, fuses, relays, switches, diodes

**consumables** include: light ballast, fluorescent lighting

Knowledge		
	Learning Outcomes	Learning Objectives
D-19.03.01L	demonstrate knowledge of electrical <b>components</b> and <b>accessories</b> , their characteristics, applications and operation	identify types of electrical <b>components</b> and <b>accessories</b> , and describe their characteristics and applications
		describe operating principles of electricity and electrical <b>components</b>

		interpret wiring schematics and logic diagrams
		identify systems with stored energy sources
D-19.03.02L	demonstrate knowledge of <b>high-voltage electrical systems</b> , their characteristics, applications and operation	identify hazards and describe safe work practices pertaining to <b>high-voltage electrical systems</b>
D-19.03.03L	demonstrate knowledge of procedures to repair electrical <b>components</b> and <b>accessories</b>	identify <b>tools and equipment</b> used to repair electrical <b>components</b> and <b>accessories</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to electrical <b>components</b> and <b>accessories</b>
		describe procedures to clean, replace and repair electrical <b>components</b> and <b>accessories</b>
		describe procedures to recycle and dispose of electrical <b>components</b> , <b>accessories</b> and <b>consumables</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-19.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to electrical <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: terminals, sockets, junction boxes, light bulbs, fuses, harnesses, plug-in connectors, wiring, resistors, relays, switches, diodes, breakers

**accessories** include: driving lights, rotary beacons, block heaters, auxiliary power units, seat heaters

**high-voltage electrical systems** include: hybrid, EV, lighting (fluorescents, dash lights)

**tools and equipment** include: multimeters, test lights, hand tools, terminal and connector repair tools

**hazards** include: electrocution, shocks, sparks, moving parts

**consumables** include: light ballast, fluorescent lighting

## Task D-20 Services, diagnoses and repairs vehicle management systems and electronic components

### Task Descriptor

Technological advancement throughout the industry has resulted in more complex vehicle management and electronic systems. Truck and transport mechanics must have a good understanding of the integration between vehicle management systems and other electronic components in a multiplex wiring system.

#### D-20.01 Services vehicle management systems and electronic components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
D-20.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-20.01.02P	perform sensory inspections	sensory inspections are performed to identify <b>component</b> securement, loose and faulty wiring, and <b>damages</b> according to <b>manufacturers' service information</b>
D-20.01.03P	check and manage fault codes	fault codes are checked and managed according to <b>manufacturers' service information</b>
D-20.01.04P	perform software updates	software updates are performed according to <b>manufacturers' service information</b>
D-20.01.05P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**tools and equipment** include: electronic service tools, scan tools, multimeters, oscilloscope

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, information bulletins

**components** include: actuators, sensors, ECMs, multi-function controls, wiring, connectors, data links, communication plugs, terminating resistors

**damages** include: overheating and exposure to moisture and contaminants, gauges not sweeping, communication problems, low voltage, failed modules, poor grounds, failed or out of adjustment sensors

Knowledge		
	Learning Outcomes	Learning Objectives
D-20.01.01L	demonstrate knowledge of vehicle management systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of vehicle management systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of vehicle management systems and their <b>components</b>
		identify and interpret <b>manufacturers' service information</b>
		describe <b>communication protocols</b> , their characteristics and applications
		describe network structure and components, their characteristics and applications
D-20.01.02L	demonstrate knowledge of procedures to service vehicle management systems and their <b>components</b>	identify data links and describe network communication between modules
		identify <b>tools and equipment</b> used to service vehicle management systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to vehicle management systems and their <b>components</b>
		describe procedures to inspect vehicle management systems and their <b>components</b>
		describe procedures to service vehicle management systems and their <b>components</b>
		describe <b>handling procedures for electronic components</b>
		identify materials that can be reconditioned, reused or recycled
D-20.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to vehicle management systems and electronic components	identify practices that reduce material waste
		identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies



## Range of Variables

**components** include: actuators, sensors, ECMs, multi-function controls, wiring, connectors, data links, communication plugs, terminating resistors

**types of vehicle management systems** include: daytime running lights (DRL), ABS/traction control, vehicle stability control, driver communication, adaptive cruise control, supplemental restraint system (SRS), remote monitoring systems, lane departure systems, multiplex electrical systems

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, information bulletins

**communication protocols** include: J1939, Bluetooth, Wi-Fi

**tools and equipment** include: electronic service tools, scan tools, multimeters, oscilloscope

**hazards** include: shocks, sparks

**handling procedures for electronic components** include: avoiding static electricity, moisture and other contaminants

### D-20.02 Diagnoses vehicle management systems and electronic components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
D-20.02.01P	identify <b><i>symptoms of problems</i></b>	<b><i>symptoms of problems</i></b> are identified by consulting with customer or operator
D-20.02.02P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
D-20.02.03P	perform sensory inspections	sensory inspections are performed to identify loose and faulty wiring, and <b><i>damages</i></b>
D-20.02.04P	check and interpret fault codes	fault codes are checked and interpreted according to <b><i>manufacturers' service information</i></b>
D-20.02.05P	perform diagnostic procedures	diagnostic procedures are performed by following <b><i>manufacturers' service information</i></b> to determine failure
D-20.02.06P	perform tests	tests are performed according to <b><i>manufacturers' service information</i></b>
D-20.02.07P	compare test results to <b><i>manufacturers' service information</i></b> or expected values	test results are compared to <b><i>manufacturers' service information</i></b> or expected values to verify diagnosis
D-20.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure

D-20.02.09P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty purposes
D-20.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: intermittent or no operation, component not operating as expected, gauges not sweeping or all the time, indicator lights, dash messages

**tools and equipment** include: scan tools, multimeters, oscilloscopes, electronic service tools, OEM specialty diagnostic tools, hand tools, wiring repair tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards, service bulletins, logic diagrams

**damages** include: overheating, exposure to moisture or other contaminants, chafed wiring, improper connections

**next steps** include: repairs, component replacement or adjustment, software updates, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
D-20.02.01L	demonstrate knowledge of vehicle management systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of vehicle management systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of vehicle management systems and their <b>components</b>
		identify and interpret <b>manufacturers' service information</b>
		describe <b>communication protocols</b> , their characteristics and applications
		describe network structure and components, their characteristics and applications
D-20.02.02L	demonstrate knowledge of procedures to diagnose vehicle management systems and their <b>components</b>	identify data links and describe network communication between modules
		identify <b>tools and equipment</b> used to diagnose vehicle management systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to vehicle management systems and their <b>components</b>
		describe procedures to inspect vehicle management systems and their <b>components</b>

		describe procedures to test vehicle management systems and their <b>components</b>
		describe procedures to diagnose vehicle management systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		describe procedures to release stored energy
		identify <b>types of wiring</b> and standards
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
D-20.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to vehicle management systems and their components	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: actuators, sensors, ECMs, multi-function controls, wiring, connectors, data links, communication plugs, terminating resistors

**types of vehicle management systems** include: DRL, ABS/traction control, vehicle stability control, driver communication, adaptive cruise control, SRS, remote monitoring systems, lane departure systems, multiplex electrical systems

**manufacturers' service information** include: specifications, recommendations, procedures, standards, service bulletins, logic diagrams

**communication protocols** include: J1939, Bluetooth, Wi-Fi

**tools and equipment** include: scan tools, multimeters, oscilloscopes, electronic service tools, OEM specialty diagnostic tools, hand tools, wiring repair tools

**hazards** include: shocks, sparks

**symptoms of problems** include: intermittent or no operation, component not operating as expected, gauges not sweeping or all the time, indicator lights, dash messages

**types of wiring** include: shielded, multi-strand, twisted pairs, coaxial, fibre optic, insulation

## D-20.03 Repairs vehicle management systems and electronic components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
D-20.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
D-20.03.02P	check and perform software updates	software updates are checked and performed according to <b>manufacturers' service information</b>
D-20.03.03P	remove power supply and release stored energy	power supply is removed and stored energy is released by disconnecting power sources and allowing capacitors to discharge in SRS modules
D-20.03.04P	replace <b>components</b>	<b>components</b> are replaced according to <b>manufacturers' service information</b>
D-20.03.05P	repair <b>components</b>	<b>components</b> are repaired according to <b>manufacturers' service information</b>
D-20.03.06P	adjust <b>components</b>	<b>components</b> are adjusted according to <b>manufacturers' service information</b>
D-20.03.07P	reprogram ECM to accommodate <b>accessories and modifications</b>	ECM is reprogrammed according to <b>manufacturers' service information</b> to accommodate <b>accessories and modifications</b>
D-20.03.08P	verify repairs	repair is verified under normal operating conditions to ensure it is within <b>manufacturers' service information</b>
D-20.03.09P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: scan tools, multimeters, oscilloscopes, electronic service tools, OEM specialty diagnostic tools, hand tools, wiring and terminal repair tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards, service bulletins, logic diagrams

**components** (to be replaced) include: ECMs, connectors, switches, solenoids, sensors, terminating resistors, wiring, harnesses, actuators

**components** (to be repaired) include: wiring, connectors, terminals

**components** (to be adjusted) include: actuators, switches, sensors

**accessories and modifications** include: addition of auxiliary lighting systems, addition of auxiliary components, change in operating characteristics

Knowledge		
	Learning Outcomes	Learning Objectives
D-20.03.01L	demonstrate knowledge of vehicle management systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of vehicle management systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of vehicle management systems and their <b>components</b>
		interpret information pertaining to vehicle management systems found in <b>manufacturers' service information</b>
		describe <b>communication protocols</b> , their characteristics and applications
		describe network structure and components, their characteristics and applications
D-20.03.02L	demonstrate knowledge of procedures to repair vehicle management systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair vehicle management systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to vehicle management systems and their <b>components</b>
		describe procedures to release stored energy
		describe procedures to repair vehicle management systems and their <b>components</b>
		describe <b>procedures to repair wiring</b>
		identify <b>types of wiring</b> and standards
		describe procedures to reprogram ECMs
		describe procedures to perform software updates
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste

D-20.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to vehicle management systems and their components	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: actuators, sensors, ECMs, multi-function controls, wiring, connectors, data links, communication plugs, terminating resistors

**types of vehicle management systems** include: DRL, ABS/traction control, vehicle stability control, driver communication, adaptive cruise control, SRS, remote monitoring systems, lane departure systems, multiplex electrical systems

**manufacturers' service information** include: specifications, recommendations, procedures, standards, service bulletins, logic diagrams

**communication protocols** include: J1939, Bluetooth, Wi-Fi

**tools and equipment** include: scan tools, multimeters, oscilloscopes, electronic service tools, OEM specialty diagnostic tools, hand tools, wiring and terminal repair tools

**hazards** include: shocks, sparks

**procedures to repair wiring** include: soldering, heat shrinking, terminal installation, insulation protection

**types of wiring** include: shielded, multi-strand, twisted pairs, coaxial, fibre optic, insulation

# Major Work Activity E

## Services, diagnoses and repairs drive trains

### Task E-21 Services, diagnoses and repairs clutches

#### Task Descriptor

The clutch transfers energy and provides a means of disconnect from the engine to the transmission. Truck and transport mechanics must diagnose, service and repair the clutch to increase longevity and optimal performance of the vehicle. Servicing includes lubrication and adjustment of components as well as routine maintenance.

#### E-21.01 Services clutches

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
E-21.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b><i>manufacturers' service information</i></b>
E-21.01.02P	lubricate cross shafts, linkages and release bearings	cross shafts, linkages and release bearings are lubricated according to <b><i>manufacturers' service information</i></b>
E-21.01.03P	adjust clutch and linkages	clutch and linkages are adjusted to obtain manufacturer's tolerance between release bearing and clutch brake
E-21.01.04P	inspect primary and secondary cylinders	primary and secondary cylinders are inspected to identify leaks and damage
E-21.01.05P	inspect and adjust cables, linkages and clutch brakes	cables, linkages and clutch brakes are inspected and adjusted according to <b><i>manufacturers' service information</i></b>

#### Range of Variables

***manufacturers' service information*** include: maintenance schedule, specifications, recommendations, procedures, standards

Knowledge		
	Learning Outcomes	Learning Objectives
E-21.01.01L	demonstrate knowledge of clutches, their <b>components</b> , characteristics, applications and operation	identify <b>types of clutches</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of clutches and their <b>components</b>
		identify types of <b>clutch controls</b> , and describe their characteristics and applications
E-21.01.02L	demonstrate knowledge of procedures to service clutches and their <b>components</b>	identify tools and equipment used to service clutches and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to clutches and their <b>components</b>
		describe procedures to inspect clutches and their <b>components</b>
		describe procedures to lubricate and adjust clutches and their <b>components</b>
		identify materials that can be reconditioned, reused or recycled

### Range of Variables

**components** include: discs, centre plate, release springs, release bearings

**types of clutches** include: pull, push, self-adjusting, manual adjusting

**clutch controls** include: cable, linkage, hydraulic-assisted, air-assisted, electronically controlled

**hazards** include: pinch/crush points, airborne contaminants, fluid leaks, air leaks

### E-21.02 Diagnoses clutches

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-21.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-21.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>



E-21.02.03P	perform <b>sensory inspections</b> and road test	<b>sensory inspections</b> and road test are performed to confirm complaint and establish preliminary diagnosis
E-21.02.04P	inspect primary and secondary cylinders, and related hoses and lines	primary and secondary cylinders, and related hoses and lines are inspected for leaks and damage
E-21.02.05P	compare results to <b>manufacturers' service information</b> or expected values to verify diagnosis	results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
E-21.02.06P	perform failure analysis	failure analysis is performed to determine root cause of failure
E-21.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: hard shifting, loss of pedal free play, excessive pedal free play, slipping clutch, high engine RPMs, difficult initial gear engagement

**tools and equipment** include: feeler gauges, spring gauges, measuring devices

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: pedal feel, observing clutch material, worn or broken components

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-21.02.01L	demonstrate knowledge of clutches, their <b>components</b> , characteristics, applications and operation	identify <b>types of clutches</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of clutches and their <b>components</b>
		identify types of <b>clutch controls</b> and describe their characteristics and applications
		identify and describe <b>clutch faults</b>
E-21.02.02L	demonstrate knowledge of procedures to diagnose clutches and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose clutches and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to clutches and their <b>components</b>
		describe procedures to inspect clutches and their <b>components</b>
		describe procedures to test clutches and their <b>components</b>
		describe procedures to diagnose clutches and their <b>components</b>

	identify steps for failure analysis
	describe common causes and <b>symptoms of problems</b>
	identify materials that can be reconditioned, reused or recycled

## Range of Variables

**components** include: discs, centre plate, release springs, release bearings, clutch break

**types of clutches** include: pull, push, self-adjusting, manual adjusting

**clutch controls** include: cable, linkage, hydraulic-assisted, air-assisted, electronically controlled

**clutch faults** include: shock loads, worn parts, seized release bearings, broken clutch springs

**tools and equipment** include: feeler gauges, spring gauges, measuring devices

**hazards** include: pinch/crush points, airborne contaminants, fluid leaks, air leaks

**symptoms of problems** include: hard shifting, loss of pedal free play, excessive pedal free play, slipping clutch, high engine RPMs, difficult initial gear engagement

## E-21.03 Repairs clutches

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
E-21.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-21.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-21.03.03P	recondition or replace flywheels	flywheels are reconditioned or replaced according to <b>manufacturers' service information</b>
E-21.03.04P	verify alignment of discs and pressure plates	alignment of discs and pressure plates is verified according to <b>manufacturers' service information</b>
E-21.03.05P	adjust clutch and linkages	clutch and linkages are adjusted to <b>manufacturers' service information</b>
E-21.03.06P	bleed air from primary and secondary cylinders	air from primary and secondary cylinders are bled
E-21.03.07P	verify repairs	repairs are verified using <b>methods</b>
E-21.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: linkages, cross shafts, bushings, clutch, pressure plate, fly wheels

**methods** include: road testing, sensory observations

Knowledge		
	Learning Outcomes	Learning Objectives
E-21.03.01L	demonstrate knowledge of clutches, their <b>components</b> , characteristics, applications and operation	identify <b>types of clutches</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of clutches and their <b>components</b>
		identify types of <b>clutch controls</b> , and describe their characteristics and applications
E-21.03.02L	demonstrate knowledge of procedures to repair clutches and their <b>components</b>	identify tools and equipment used to repair clutches and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to clutches and their <b>components</b>
		describe procedures to remove, replace, adjust and repair clutches and their <b>components</b>
		identify materials that can be reconditioned, reused or recycled

## Range of Variables

**components** include: linkages, cross shafts, bushings, clutch, pressure plate, fly wheels

**types of clutches** include: pull, push, self-adjusting, manual adjusting

**clutch controls** include: cable, linkage, hydraulic-assisted, air-assisted, electronically controlled

**hazards** include: pinch/crush points, airborne contaminants, fluid leaks, air leaks, heavy components, clutch break

## Task E-22 Services, diagnoses and repairs manual transmissions and transfer cases

### Task Descriptor

The transmission of a vehicle transfers power from the engine through the drive shaft to the wheels to enable movement of the vehicle. The transmission allows for selection of gear ratios needed for various loads and speed conditions. The transfer case allows transmission power to be directed to components such as additional axles and accessories.

Truck and transport mechanics diagnose, service and repair transmission and transfer cases minimizing down time of the vehicle, and ensuring the safety of the vehicle, driver and public. Servicing includes routine maintenance.

#### E-22.01 Services manual transmissions and transfer cases

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-22.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-22.01.02P	clean <b>components</b> for inspection	<b>components</b> are cleaned for inspection
E-22.01.03P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
E-22.01.04P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
E-22.01.05P	inspect <b>manual transmission and transfer case components</b>	<b>manual transmission and transfer case components</b> are inspected for leakage and damage
E-22.01.06P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be cleaned) include: breathers, transmission cases

**consumables** include: oil, filter

**manual transmission and transfer case components** include: seals, gaskets, gears, bearings, splines, air cylinders, range valves, air lines, filters, synchronizers, main shafts, counter shafts, detent, shift rails

Knowledge		
	Learning Outcomes	Learning Objectives
E-22.01.01L	demonstrate knowledge of manual transmissions, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of manual transmissions</b> and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of manual transmissions and their <b>components</b>
E-22.01.02L	demonstrate knowledge of transfer cases, their <b>components</b> , characteristics, applications and operation	identify types of transfer cases and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of transfer cases and their <b>components</b> , and <b>transfer case shift controls</b>
		identify <b>auxiliary shift components</b> , and describe their characteristics and applications
E-22.01.03L	demonstrate knowledge of procedures to service manual transmissions and transfer cases, and their <b>components</b>	identify tools and equipment used to service manual transmissions and transfer cases, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> safe work practices pertaining to manual transmissions and transfer cases, and their <b>components</b>
		describe procedures to inspect <b>manual transmission and transfer case components</b>
		describe procedures to clean <b>components</b>
		describe procedures to remove, replace, recycle and dispose of <b>consumables</b>
E-22.01.04L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of oils	identify standards and regulations pertaining to recycling and disposal of oils

## Range of Variables

**components** include: breathers, transmission cases

**consumables** include: oil, filter

**types of manual transmissions** include: single countershaft, multiple countershaft, synchronized, non-synchronized

**transfer case shift controls** include: air, electrical, mechanical

**auxiliary shift components** include: air cylinders, air lines, regulators, shift knobs

**hazards** include: spills, pinch/crush points, sharp edges

**manual transmission and transfer case components** include: seals, gaskets, gears, bearings, splines, air cylinders, range valves, air lines, filters, synchronizers, main shafts, counter shafts, detent, shift rails

## E-22.02 Diagnoses manual transmissions and transfer cases

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-22.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-22.02.02P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-22.02.03P	perform diagnostic procedures	diagnostic procedures are performed by following <b>manufacturers' service information</b> to confirm complaint
E-22.02.04P	compare test results to <b>manufacturers' service information</b> or expected values	test results are compared to <b>manufacturers' service information</b> or expected values
E-22.02.05P	perform failure analysis	failure analysis is performed to determine root cause of failure
E-22.02.06P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
E-22.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: hard shifting, jumping out of gear, noises

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-22.02.01L	demonstrate knowledge of manual transmissions, their <b>components</b> , characteristics, applications and operation	identify <b>types of manual transmissions</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of manual transmissions and their <b>components</b>
		interpret information pertaining to manual transmissions found in <b>manufacturers' service information</b>
E-22.02.02L	demonstrate knowledge of transfer cases, their <b>components</b> , characteristics, applications and operation	identify types of transfer cases and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of transfer cases and their <b>components</b> , and <b>transfer case shift controls</b>
		identify <b>auxiliary shift components</b> , and describe their characteristics and applications
E-22.02.03L	demonstrate knowledge of procedures to diagnose manual transmissions and transfer cases, and their <b>components</b>	identify tools and equipment used to diagnose manual transmissions and transfer cases, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to manual transmissions and transfer cases, and their <b>components</b>
		describe procedures to inspect manual transmissions and transfer cases, and their <b>components</b>
		describe procedures to test manual transmissions and transfer cases, and their <b>components</b>
		describe procedures to diagnose manual transmissions and transfer cases, and their <b>components</b>
		identify steps for failure analysis
		identify common <b>faults</b> found in manual transmissions and transfer cases, and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled

## Range of Variables

**manual transmission and transfer case components** include: seals, gaskets, gears, bearings, splines, air cylinders, range valves, air lines, filters, synchronizers, main shafts, counter shafts, detent, shift rails

**types of manual transmissions** include: single countershaft, multiple countershaft, synchronized, non-synchronized

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**transfer case shift controls** include: air, electrical, mechanical

**auxiliary shift components** include: air cylinders, air lines, regulators, shift knobs

**hazards** include: spills, pinch/crush points, sharp edges

**faults** include: missing teeth in gears, lack of lubrication, worn synchronizers

**symptoms of problems** include: hard shifting, jumping out of gear, noises

### E-22.03 Repairs manual transmissions and transfer cases

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
E-22.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-22.03.02P	repair <b>manual transmission and transfer case components</b>	<b>manual transmission and transfer case components</b> are repaired according to <b>manufacturers' service information</b>
E-22.03.03P	rebuild manual transmissions and transfer cases	manual transmissions and transfer cases are rebuilt by replacing worn or broken parts according to <b>manufacturers' service information</b>
E-22.03.04P	remove and replace worn, damaged and faulty <b>manual transmission and transfer case components</b>	worn, damaged and faulty <b>manual transmission and transfer case components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-22.03.05P	time gears and adjust bearing pre-loads	gears are timed and bearing pre-loads are adjusted according to <b>manufacturers' service information</b>
E-22.03.06P	install PTOs and adjust gear backlash	PTOs are installed and gear backlash is adjusted according to <b>manufacturers' service information</b>
E-22.03.07P	verify repairs	repairs are verified using <b>methods</b>
E-22.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking



## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**manual transmission and transfer case components** include: seals, gaskets, gears, bearings, splines, air cylinders, range valves, air lines, filters, synchronizers, main shafts, counter shafts, detent, shift rails

**methods** include: road testing, sensory observations

Knowledge		
	Learning Outcomes	Learning Objectives
E-22.03.01L	demonstrate knowledge of manual transmissions, their <b>components</b> , characteristics, applications and operation	identify <b>types of manual transmissions</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of manual transmissions and their <b>components</b>
E-22.03.02L	demonstrate knowledge of transfer cases, their <b>components</b> , characteristics, applications and operation	identify types of transfer cases and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of transfer cases and their <b>components</b> , and <b>transfer case shift controls</b>
		identify <b>auxiliary shift components</b> and describe their characteristics and applications
E-22.03.03L	demonstrate knowledge of procedures to repair manual transmissions and transfer cases, and their <b>components</b>	identify tools and equipment used to repair manual transmissions and transfer cases, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to manual transmissions and transfer cases, and their <b>components</b>
		describe procedures to remove, replace, rebuild and repair manual transmissions and transfer cases, and their <b>components</b>
		identify materials that can be reconditioned, reused or recycled

## Range of Variables

**manual transmission and transfer case components** include: seals, gaskets, gears, bearings, splines, air cylinders, range valves, air lines, filters, synchronizers, main shafts, counter shafts, detent, shift rails

**types of manual transmissions** include: single countershaft, multiple countershaft, synchronized, non-synchronized

**transfer case shift controls** include: air, electrical, mechanical

**auxiliary shift components** include: air cylinder, air lines, regulators, shift knobs

**hazards** include: spills, pinch/crush points, sharp edges, heavy components

## Task E-23 Services, diagnoses and repairs automatic transmissions

### Task Descriptor

Truck and transport mechanics must have a good understanding of automatic transmission operation and components in order to service, diagnose and repair, ensure proper function and reduce downtime.

#### E-23.01 Services automatic transmissions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
E-23.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-23.01.02P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify leaks, breaks and excessive wear
E-23.01.03P	check and perform software updates	software is checked and updates are performed according to <b>manufacturers' service information</b>
E-23.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
E-23.01.05P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
E-23.01.06P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: torque converters, valve bodies, pumps, solenoids, clutches, clutch packs, bearings, seals, bands, servos, planetaries

**consumables** include: oil, filters

## Knowledge

Learning Outcomes		Learning Objectives
E-23.01.01L	demonstrate knowledge of automatic transmissions, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify automatic transmissions and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of automatic transmissions and their <b>components</b>
		identify automatic hybrid transmissions, and describe their characteristics and applications
		identify types of coolers, and describe their locations, characteristics and applications
E-23.01.02L	demonstrate knowledge of procedures to service automatic transmissions and their <b>components</b>	identify tools and equipment used to service automatic transmissions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to automatic transmissions and their <b>components</b>
		describe procedures to inspect automatic transmission <b>components</b>
		describe procedures to service automatic transmission <b>components</b>
		describe procedures to remove, replace, recycle and dispose of automatic transmission <b>consumables</b>
		describe procedures to perform software updates and calibrations
		describe procedures to disconnect and reconnect high-voltage systems in hybrid vehicles
		describe effects of <b>component</b> failures
E-23.01.03L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of automatic transmission <b>consumables</b>	identify materials that can be reconditioned, reused or recycled
		identify and interpret standards and regulations pertaining to recycling and disposal of automatic transmission <b>consumables</b>
E-23.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to automatic transmissions and their components	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: torque converters, valve bodies, pumps, solenoids, clutches, clutch packs, bearings, seals, bands, servos, planetaries

**consumables** include: oil, filters

**hazards** include: fluid spills, sharp edges, hot fluids

### E-23.02 Diagnoses automatic transmissions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-23.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-23.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-23.02.03P	check for external leaks and oil condition	external leaks and oil condition are checked
E-23.02.04P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
E-23.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
E-23.02.06P	assess <b>components</b> for wear, damage and defects	<b>components</b> are assessed for wear, damage and defects by performing road test and using <b>tools and equipment</b>
E-23.02.07P	interpret fault codes and <b>test</b> results	fault codes and <b>test</b> results are interpreted to ensure operation is according to <b>manufacturers' service information</b>
E-23.02.08P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
E-23.02.09P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
E-23.02.10P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: harsh shifting, noises, delayed shift, no gear selection

**tools and equipment** include: pressure gauges, electronic service tools, manufacturer-specific equipment

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**sensory inspections** include: road testing, checking for leaks, smells, noises, wiggling components

**components** include: torque converters, valve bodies, pumps, solenoids, clutches, clutch packs, bearings, seals, bands, servos, planetaries

**tests** include: stall testing, pressure readings, temperature

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-23.02.01L	demonstrate knowledge of automatic transmissions, their <b>components</b> , characteristics, applications and operation	identify automatic transmissions and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of automatic transmissions and their <b>components</b>
		interpret information pertaining to automatic transmissions found in <b>manufacturers' service information</b> and fault codes
		identify hybrid transmissions, and describe their characteristics and applications
		identify types of coolers, and describe their locations, characteristics and applications
E-23.02.02L	demonstrate knowledge of procedures to diagnose automatic transmissions and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose automatic transmissions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to automatic transmissions and their <b>components</b>
		describe procedures to inspect automatic transmissions and their <b>components</b>
		describe procedures to test automatic transmissions and their <b>components</b>
		describe procedures to diagnose automatic transmissions and their <b>components</b>
		describe procedures to perform software updates and calibrations
		describe common causes and <b>symptoms of problems</b>
		describe effects of <b>component</b> failures

		identify materials that can be reconditioned, reused or recycled
E-23.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to automatic transmissions	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: torque converters, valve bodies, pumps, solenoids, clutches, clutch packs, bearings, seals, bands, servos, planetaries

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**tools and equipment** include: pressure gauges, electronic service tools, manufacturer-specific equipment

**hazards** include: fluid spills, sharp edges, hot fluids

**symptoms of problems** include: harsh shifting, noises, delayed shift, no gear selection

## E-23.03 Repairs automatic transmissions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
E-23.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-23.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-23.03.03P	verify most current version of software is installed in ECM	software installed in ECM is verified to ensure it is most up-to-date version
E-23.03.04P	disconnect and reconnect high-voltage systems in hybrid vehicles	high-voltage systems in hybrid vehicles are disconnected and reconnected according to <b>manufacturers' service information</b>
E-23.03.05P	rebuild transmission	transmission is rebuilt according to <b>manufacturers' service information</b>
E-23.03.06P	repair transmission	transmission is repaired by replacing <b>internal components</b> and <b>external components</b> according to <b>manufacturers' service information</b>

E-23.03.07P	verify repairs	repairs are verified using <b>methods</b> to ensure operation according to <b>manufacturers' service information</b>
E-23.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: pressure gauges, electronic service tools, manufacturer-specific equipment

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** include: torque converters, valve bodies, pumps, solenoids, clutches, clutch packs, bearings, seals, bands, servos, planetaries

**internal components** include: torque converters, pumps, valve bodies

**external components** include: oil coolers, hydraulic retarder

**methods** include: road testing, function testing, stall testing

Knowledge		
	Learning Outcomes	Learning Objectives
E-23.03.01L	demonstrate knowledge of automatic transmissions, their <b>components</b> , characteristics, applications and operation	identify automatic transmissions and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of automatic transmissions and their <b>components</b>
		interpret information pertaining to automatic transmissions found in <b>manufacturers' service information</b> and fault codes
		identify automatic hybrid transmissions, and describe their characteristics and applications
		identify types of coolers, and describe their locations, characteristics and applications
E-23.03.02L	demonstrate knowledge of procedures to repair automatic transmissions and their <b>components</b>	identify <b>tools and equipment</b> used to repair automatic transmissions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to automatic transmissions and their <b>components</b>
		describe procedures to remove, replace, adjust and repair automatic transmissions and their <b>components</b>
		describe procedures to perform software updates and calibrations

		describe procedures to disconnect and reconnect high-voltage systems in hybrid vehicles
		describe effects of <b>component</b> failures
		identify materials that can be reconditioned, reused or recycled
E-23.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to automatic transmissions and their <b>components</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: torque converters, valve bodies, pumps, solenoids, clutches, clutch packs, bearings, seals, bands, servos, planetaries

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**tools and equipment** include: pressure gauges, electronic service tools, manufacturer-specific equipment

**hazards** include: fluid spills, sharp edges, hot fluids, pinch/crush points

## Task E-24 Services, diagnoses and repairs automated transmissions

### Task Descriptor

The automated transmission is a standard transmission shifted automatically using computer controlled actuators and may have a clutch pedal and electronic gear selector.

Truck and transport mechanics service, diagnose and repair automated transmissions to ensure proper function and reduce down time.

### E-24.01 Services automated transmissions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
E-24.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-24.01.02P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify leaks, breaks and excessive wear



E-24.01.03P	check and perform software updates	software is checked and updates are performed according to <b>manufacturers' service information</b>
E-24.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule
E-24.01.05P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
E-24.01.06P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: wiring, solenoids, sensors, actuators, force motors, ECMs

**consumables** include: oil, filters

Knowledge		
	Learning Outcomes	Learning Objectives
E-24.01.01L	demonstrate knowledge of automated transmissions, their <b>components</b> , characteristics, applications and operation	identify automated transmissions and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of automated transmissions and their <b>components</b>
		identify electrical components and circuits, and describe their characteristics and applications
		identify automated hybrid transmissions, and describe their characteristics and applications
		describe effects of <b>component</b> failures
E-24.01.02L	demonstrate knowledge of procedures to service automated transmissions and their <b>components</b>	identify tools and equipment used to service automated transmissions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to automated transmissions and their <b>components</b>
		describe procedures to inspect automated transmission <b>components</b>
		describe procedures to service automated transmission <b>components</b>

		describe procedures to perform software updates and calibrations
		describe procedures to remove, replace, recycle and dispose of automated transmission <b>consumables</b>
		describe procedures to disconnect and reconnect high-voltage systems in hybrid vehicles
		identify materials that can be reconditioned, reused or recycled
E-24.01.03L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of automatic transmission <b>consumables</b>	identify codes, standards and regulations to pertaining to recycling and disposal of automatic transmission <b>consumables</b>
E-24.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to automated transmissions	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: wiring, solenoids, sensors, actuators, force motors, ECMs

**hazards** include: fluid spills, sharp edges, hot fluids

**consumables** include: oil, filters

## E-24.02 Diagnoses automated transmissions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
E-24.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-24.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-24.02.03P	check for external leaks and oil condition	external leaks and oil condition are checked
E-24.02.04P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
E-24.02.05P	perform diagnostic procedures	diagnostic procedures are performed by following <b>manufacturers' service information</b> to determine failure
E-24.02.06P	perform tests	tests are performed using <b>tools and equipment</b>

E-24.02.07P	assess <b>components</b> for wear, damage and defects	<b>components</b> are assessed for wear, damage and defects by performing road test and using <b>tools and equipment</b>
E-24.02.08P	interpret fault codes and test results	fault codes and test results are interpreted to ensure operation is according to <b>manufacturers' service information</b>
E-24.02.09P	compare test results to <b>manufacturers' service information</b> or expected values	test results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
E-24.02.10P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
E-24.02.11P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: noises, hard shifting, poor changing or stuck gears

**tools and equipment** include: electronic service tools, manufacturer-specific equipment

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**sensory inspections** include: road testing; checking for leaks, smells, noises and wiggling components

**components** include: wiring, solenoids, sensors, actuators, motors, ECMs, oils

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-24.02.01L	demonstrate knowledge of automated transmissions, their <b>components</b> , characteristics, applications and operation	<p>identify automated transmissions and their <b>components</b>, and describe their characteristics and applications</p> <p>describe operating principles of automated transmissions and their <b>components</b></p> <p>interpret information pertaining to automated transmissions found in <b>manufacturers' service information</b></p> <p>identify electrical components and circuits, and describe their characteristics and applications</p> <p>identify automated hybrid transmissions, and describe their characteristics and applications</p>
E-24.02.02L	demonstrate knowledge of procedures to diagnose automated transmissions and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose automated transmissions and their <b>components</b> , and describe their applications and procedures for use

		identify <b>hazards</b> and describe safe work practices pertaining to automated transmissions and their <b>components</b>
		describe procedures to inspect automated transmissions and their <b>components</b>
		describe procedures to test automated transmissions and their <b>components</b>
		describe procedures to diagnose automated transmissions and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		describe procedures to perform software updates and calibrations
		identify common <b>faults</b> in automated transmissions and their <b>components</b>
		describe effects of <b>component</b> failures
		identify materials that can be reconditioned, reused or recycled
E-24.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to automated transmissions	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: wiring, solenoids, sensors, actuators, motors, ECMs, oils

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**tools and equipment** include: electronic service tools, manufacturer-specific equipment

**hazards** include: fluid spills, sharp edges, hot fluids

**symptoms of problems** include: noises, hard shifting, poor changing or stuck gears

**faults** include: missing teeth in gears, lack of lubrication, worn synchronizers, hard shifting, jumping out of gear, noises, defective automated controls

## E-24.03 Repairs automated transmissions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-24.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-24.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-24.03.03P	verify most current version of software is installed in ECM	software installed in ECM is verified to ensure it is most up-to-date version
E-24.03.04P	disconnect and reconnect high-voltage systems in hybrid vehicles	high-voltage systems in hybrid vehicles are disconnected and reconnected according to <b>manufacturers' service information</b>
E-24.03.05P	rebuild transmission	transmission is rebuilt according to <b>manufacturers' service information</b>
E-24.03.06P	repair transmission	transmission is repaired by replacing <b>internal components</b> and <b>external components</b> according to <b>manufacturers' service information</b>
E-24.03.07P	verify repairs	repairs are verified using <b>methods</b> to ensure operation according to <b>manufacturers' service information</b>
E-24.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**manufacturers' service information** include: specifications, recommendations, procedures, standards  
**components** include: wiring, solenoids, sensors, actuators, motors, ECMs, oils, valves, hoses, lines, gaskets, wiring harnesses, gears, bearings

**internal components** include: gears, bearings, detents, shift rails, synchronizers

**external components** include: solenoids, wiring harnesses, speed sensors

**methods** include: road testing, function testing, electrical testing

Knowledge		
	Learning Outcomes	Learning Objectives
E-24.03.01L	demonstrate knowledge of automated transmissions, their <b>components</b> , characteristics, applications and operation	identify automated transmissions and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of automated transmissions and their <b>components</b>
		interpret information pertaining to automated transmissions and their <b>components</b> found in <b>manufacturers' service information</b>
		identify electrical components and circuits, and describe their characteristics and applications
		identify automated hybrid transmissions, and describe their characteristics and applications
E-24.03.02L	demonstrate knowledge of procedures to repair automated transmissions and their <b>components</b>	identify tools and equipment used to repair automated transmissions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to automated transmissions and their <b>components</b>
		describe procedures to remove, replace, adjust and repair automated transmissions and their <b>components</b>
		describe procedures to perform software updates and calibrations
		describe procedures to disconnect and reconnect high-voltage systems in hybrid vehicles
		describe effects of <b>component</b> failures
E-24.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to automated transmissions	identify materials that can be reconditioned, reused or recycled
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: wiring, solenoids, sensors, actuators, motors, ECMs, oils, valves, hoses, lines, gaskets, wiring harnesses, gears, bearings

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**hazards** include: fluid spills, sharp edges, hot fluids, pinch/crush points

## Task E-25 Services, diagnoses and repairs driveline systems

### Task Descriptor

The driveline provides a mechanical linkage between the transmission and the drive axle. A truck and transport mechanic must understand the influence of driveline length, angles and correct phasing on the driveline system.

#### E-25.01 Services driveline systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
E-25.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-25.01.02P	perform sensory inspections	sensory inspections are performed to identify worn, damaged, loose or defective <b>components</b>
E-25.01.03P	lubricate serviceable u-joints and slip joints	serviceable u-joints and slip joints are lubricated according to <b>manufacturers' service information</b>
E-25.01.04P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**tools and equipment** include: u-joint tool, hand tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: yokes, u-joints, mounting hardware, steady bearings

#### Knowledge

	Learning Outcomes	Learning Objectives
E-25.01.01L	demonstrate knowledge of driveline systems, their <b>components</b> , characteristics, applications and operation	identify driveline systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of driveline systems and their <b>components</b>

		identify and distinguish between serviceable and non-serviceable driveline systems
E-25.01.02L	demonstrate knowledge of procedures to service driveline systems and their <b>components</b>	identify <b>tools and equipment</b> used to service driveline systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to driveline systems and their <b>components</b>
		describe procedures to inspect driveline system and their <b>components</b>
		describe procedures to service driveline system and their <b>components</b>
		describe procedures to lubricate serviceable u-joints and slip joints

## Range of Variables

**components** include: yokes, u-joints, mounting hardware, steady bearings

**tools and equipment** include: u-joint tool, hand tools

**hazards** include: tangling in PTOs, grease injection, sharp edges, airborne contaminants, crushing from heavy components

## E-25.02 Diagnoses driveline systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
E-25.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-25.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-25.02.03P	perform sensory inspections	sensory inspections of <b>components</b> are performed to confirm complaint and establish preliminary diagnosis
E-25.02.04P	describe correct orientation and phasing of drive shaft	drive shaft is checked for correct phasing and orientation
E-25.02.05P	perform <b>tests</b>	<b>tests</b> are performed to determine cause of problem or failure
E-25.02.06P	check ride height and driveline angles	ride height and driveline angles are checked to confirm driveline alignment



E-25.02.07P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
E-25.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: vibration, noises

**tools and equipment** include: vibration analyzer, angle gauges, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: u-joints, slip joints, steady bearings, motor mounts, suspension

**tests** include: road testing, angle gauge

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-25.02.01L	demonstrate knowledge of driveline systems, their <b>components</b> , characteristics, applications and operation	identify driveline systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of driveline systems and their <b>components</b>
		identify and distinguish between serviceable and non-serviceable driveline systems
		describe function of driveline savers
		identify driveline angles and support bearings, and describe their characteristics, applications and wear limits
		describe correct orientation and phasing of drive shaft
E-25.02.02L	demonstrate knowledge of procedures to diagnose driveline systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose driveline systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to driveline systems and their <b>components</b>
		describe procedures to inspect driveline systems and their <b>components</b>
		describe procedures to test driveline systems and their <b>components</b>

	describe procedures to diagnose driveline systems and their <b>components</b>
	describe common causes and <b>symptoms of problems</b>

## Range of Variables

**components** include: u-joints, slip joints, steady bearings, motor mounts, suspension

**tools and equipment** include: vibration analyzer, angle gauges, electronic service tools

**hazards** include: tangling in PTOs, grease injection, sharp edges, airborne contaminants, crushing from heavy components

**symptoms of problems** include: vibration, noises

## E-25.03 Repairs driveline systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-25.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-25.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-25.03.03P	perform <b>adjustment procedures</b>	<b>adjustment procedures</b> are performed according to <b>manufacturers' service information</b> to ensure operation of <b>components</b> and equipment
E-25.03.04P	lubricate u-joints and slip joints	u-joints and slip joints are lubricated according to <b>manufacturers' service information</b>
E-25.03.05P	verify repairs	repairs are verified using <b>methods</b>
E-25.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: u-joint tool, hand tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** include: u-joints, steady bearings, slip joints, motor mounts, suspension

**adjustment procedures** include: phasing, balancing, adjusting driveline angle

**methods** include: road testing, angle gauge

Knowledge		
	Learning Outcomes	Learning Objectives
E-25.03.01L	demonstrate knowledge of driveline systems, their <b>components</b> , characteristics, applications and operation	identify driveline systems and their <b>components</b> , and describe their characteristics and applications describe operating principles of driveline systems and their <b>components</b> identify and distinguish between serviceable and non-serviceable driveline systems describe function of driveline savers describe correct orientation and phasing of drive shaft
E-25.03.02L	demonstrate knowledge of procedures to repair driveline systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair driveline systems and their <b>components</b> , and describe their applications and procedures for use identify <b>hazards</b> and describe safe work practices pertaining to driveline systems and their <b>components</b> describe procedures to remove, replace, adjust and repair driveline systems and their <b>components</b> describe procedures to lubricate serviceable u-joints and slip joints describe procedures to install and phase driveline systems

### Range of Variables

**components** include: u-joints, steady bearings, slip joints, motor mounts, suspension

**tools and equipment** include: u-joint tool, hand tools

**hazards** include: tangling in PTOs, grease injection, sharp edges, airborne contaminants, crushing from heavy components

## Task E-26 Services, diagnoses and repairs drive axle assemblies

### Task Descriptor

The drive axle assembly transfers power from the engine and transmission to the wheels.  
Truck and transport mechanics must be able to service, diagnose and repair drive axle assemblies.

#### E-26.01 Services drive axle assemblies

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
E-26.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-26.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
E-26.01.03P	check oil level and visually inspect oil and plug condition	oil level is checked, and oil and plug condition is visually inspected during scheduled maintenance for <b>irregularities</b> according to <b>manufacturers' service information</b>
E-26.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>
E-26.01.05P	perform sensory inspections	sensory inspections of seals and gaskets are performed to identify leaks and need for repair
E-26.01.06P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
E-26.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be cleaned) include: breathers, vents

**irregularities** include: material, metal attached to drain plug, water in oil

**consumables** include: oil, filters

Knowledge		
	Learning Outcomes	Learning Objectives
E-26.01.01L	demonstrate knowledge of drive axle assemblies, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	<p>identify <b>types of drive axle assemblies</b>, their <b>components</b> and <b>consumables</b>, and describe their characteristics and applications</p> <p>describe operating principles of drive axle assemblies and their <b>components</b></p> <p>identify electrical components and circuits, and describe their characteristics and applications</p> <p>identify different weight ratings and gear ratios, and describe their characteristics and applications</p>
E-26.01.02L	demonstrate knowledge of procedures to service drive axle assemblies and their <b>components</b> and <b>consumables</b>	<p>identify tools and equipment used to service drive axle assemblies and their <b>components</b> and <b>consumables</b>, and describe their applications and procedures for use</p> <p>identify <b>hazards</b> and describe safe work practices pertaining to drive axle assemblies and their <b>components</b> and <b>consumables</b></p> <p>describe procedures to disconnect and reconnect high-voltage systems in EV</p> <p>describe procedures to inspect drive axle assemblies and their <b>components</b> and <b>consumables</b></p> <p>describe procedures to clean drive axle assemblies and their <b>components</b></p> <p>describe procedures to remove, replace and service drive axle assemblies and their <b>components</b></p> <p>describe procedures to perform software updates for electronic lock-ups and new technology</p> <p>describe procedures to remove, replace, recycle and dispose of drive axle assembly <b>consumables</b></p> <p>identify materials that can be reconditioned, reused or recycled</p>

E-26.01.03L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of drive axle assembly <b>consumables</b>	identify and interpret standards and regulations pertaining to recycling and disposal of drive axle assembly <b>consumables</b>
E-26.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to drive axle assemblies	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: seals, axle shaft, gaskets, hubs, gears, bearings, differentials

**consumables** include: oil, filters

**types of drive axle assemblies** include: locking, two-speed, limited slip, planetary drive, electric drive motors

**hazards** include: sharp edges, fluid spills

## E-26.02 Diagnoses drive axle assemblies

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
E-26.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-26.02.02P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-26.02.03P	confirm complaint	complaint is confirmed by performing road test
E-26.02.04P	check oil level and visually inspect oil, plug, filter and vent condition	oil level is checked, and oil, plug, filter and vent condition are visually inspected for <b>irregularities</b> according to <b>manufacturers' service information</b>
E-26.02.05P	inspect <b>components</b>	<b>components</b> are inspected for incorrect backlash, wear or incorrect preload according to <b>manufacturers' service information</b>
E-26.02.06P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
E-26.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: noises, inter-axle differential lock not working, no drive

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**irregularities** include: material, metal attached to drain plug, water in oil

**components** include: fork, bearings, crown and pinion gears, spider gears, differentials

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-26.02.01L	demonstrate knowledge of drive axle assemblies, their <b>components</b> , characteristics, applications and operation	identify <b>types of drive axle assemblies</b> , their <b>components</b> , and describe their characteristics and applications
		describe operating principles of drive axle assemblies and their <b>components</b>
		interpret information pertaining to drive axle assemblies found in <b>manufacturers' service information</b>
E-26.02.02L	demonstrate knowledge of procedures to diagnose drive axle assemblies and their <b>components</b>	identify different weight ratings and gear ratios, and describe their characteristics and applications
		identify tools and equipment used to diagnose drive axle assemblies and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to drive axle assemblies and their <b>components</b>
		describe procedures to inspect drive axle assemblies and their <b>components</b>
		describe procedures to test drive axle assemblies and their <b>components</b>
		describe procedures to diagnose drive axle assemblies and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled

## Range of Variables

**components** include: fork, bearings, crown and pinion gears, spider gears, differentials

**types of drive axle assemblies** include: locking, two-speed, limited slip, planetary drive, electric drive motors

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**hazards** include: sharp edges, fluid spills, pinch/crush points

**symptoms of problems** include: noises, inter-axle differential lock not working, no drive

## E-26.03 Repairs drive axle assemblies

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
E-26.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-26.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-26.03.03P	clean <b>components</b>	<b>components</b> are cleaned to remove debris and contaminants
E-26.03.04P	perform failure analysis	failure analysis is performed to determine root cause of failure
E-26.03.05P	repair <b>components</b>	<b>components</b> are repaired according to <b>manufacturers' service information</b>
E-26.03.06P	perform <b>overhaul procedures</b>	<b>overhaul procedures</b> are performed according to <b>manufacturers' service information</b>
E-26.03.07P	verify repairs	repairs are verified using <b>methods</b>
E-26.03.08P	refill housing	housing is refilled using lubricant according to <b>manufacturers' service information</b>
E-26.03.09P	confirm repairs	repairs are confirmed by performing road test
E-26.03.10P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: manufacturer-specific tools, measuring tools, hand tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** (to be removed and replaced) include: seals, gaskets, bearings, planetary gear sets, crown and pinion, differentials

**components** (to be cleaned) include: vents, housings, gasket surfaces, gears, hubs

**components** (to be repaired) include: housings, spindle threads

**overhaul procedures** include: setting and adjusting preload and backlash, checking and adjusting crown and pinion gear tooth pattern

**methods** include: marking paste, dial indicators, weight scales



Knowledge		
	Learning Outcomes	Learning Objectives
E-26.03.01L	demonstrate knowledge of drive axle assemblies, their <b>components</b> , characteristics, applications and operation	identify <b>types of drive axle assemblies</b> , their <b>components</b> , and describe their characteristics and applications
		describe operating principles of drive axle assemblies and their <b>components</b>
		interpret information pertaining to drive axle assemblies found in <b>manufacturers' service information</b>
		identify different weight ratings and gear ratios, and describe their characteristics and applications
		identify <b>types of lubricants</b> and additives, and describe their characteristics and applications
E-26.03.02L	demonstrate knowledge of procedures to repair drive axle assemblies and their <b>components</b>	identify differential or inter-axle differential lock <b>activating methods</b> , and describe their characteristics and applications
		identify <b>tools and equipment</b> used to repair drive axle assemblies and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to drive axle assemblies and their <b>components</b>
		describe procedures to disconnect and reconnect high-voltage systems in EV
		describe procedures to remove, replace, clean, adjust and repair drive axle assemblies and their <b>components</b>
		describe procedures to secure hubs to spindles using pre-set and conventional bearing types
		identify steps for failure analysis
		identify and describe <b>common faults</b> in drive axle assemblies
E-26.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to drive axle assemblies	identify materials that can be reconditioned, reused or recycled
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: seals, gaskets, bearings, planetary gear sets, crown and pinion

**types of drive axle assemblies** include: locking, two-speed, limited slip, planetary drive, electric drive motors

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**types of lubricants** include: conventional, semi-synthetic, synthetic

**activating methods** include: air, electric

**tools and equipment** include: manufacturer-specific tools, measuring tools, hand tools

**hazards** include: sharp edges, fluid spills, pinch/crush points, heavy components

**common faults** include: missing teeth in crown and pinion gears, broken or bent shift fork in inter-axle differential lock, lack of lubrication, broken or bent axles

## Task E-27 Services, diagnoses and repairs drive train retarders

### Task Descriptor

Drive train retarders are an optional component used to assist and extend the life of the primary braking system. They can be separate or combined with another component of the drive train system.

Truck and transport mechanics service, diagnose and repair drive train retarders to ensure proper function and reduce down time.

### E-27.01 Services drive train retarders

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
E-27.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
E-27.01.02P	check fluid, component mountings and wiring	fluid is checked for leaks, component mountings are checked to be secure, and wiring is checked for damage and corrosion
E-27.01.03P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule

E-27.01.04P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
E-27.01.05P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**consumables** include: oil, filters

Knowledge		
	Learning Outcomes	Learning Objectives
E-27.01.01L	demonstrate knowledge of drive train retarders, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of drive train retarders</b> and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of drive train retarders and their <b>components</b>
		interpret information pertaining to drive train retarders found in <b>manufacturers' service information</b>
E-27.01.02L	demonstrate knowledge of procedures to service drive train retarders and their <b>components</b> and <b>consumables</b>	identify tools and equipment used to service drive train retarders and their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to drive train retarders and their <b>components</b>
		describe procedures to inspect drive train retarder <b>components</b> and <b>consumables</b>
		describe procedures to service drive train retarders and their <b>components</b>
		describe procedures to remove, replace, recycle and dispose of drive train retarder <b>consumables</b>

## Range of Variables

**components** include: rotors, electromagnets, valves, sensors, pressure switches, potentiometers, lines, wiring, connectors, ECMs

**consumables** include: oil, filters

**types of drive train retarders** include: electric, hydraulic

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: moving parts, heat, pressurized fluids, electric and electromagnetic hazards

### E-27.02 Diagnoses drive train retarders

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
E-27.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
E-27.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-27.02.03P	perform sensory inspections	sensory inspections are performed to identify external leaks and loose, broken, damaged and corroded wiring
E-27.02.04P	perform diagnostic procedures and tests	diagnostic procedures and tests are performed by following <b>manufacturers' service information</b> to determine failure
E-27.02.05P	assess <b>components</b> for wear, damage and defects	<b>components</b> are assessed for wear, damage and defects
E-27.02.06P	interpret fault codes and test results	fault codes and test results are interpreted to check operation against <b>manufacturers' service information</b>
E-27.02.07P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty
E-27.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: weak performance, intermittent operation, leaks, noises

**tools and equipment include:** pressure gauges, electronic service tools, multimeters, manufacturer-specific equipment

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: rotors, electromagnets, valves, sensors, pressure switches, potentiometers, lines, wiring, connectors, ECMs

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
E-27.02.01L	demonstrate knowledge of drive train retarders, their <b>components</b> , characteristics, applications and operation	identify <b>types of drive train retarders</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of drive train retarders and their <b>components</b>
		interpret information pertaining to drive train retarders found in <b>manufacturers' service information</b>
E-27.02.02L	demonstrate knowledge of procedures to diagnose drive train retarders and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose drive train retarders and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to drive train retarders and their <b>components</b>
		describe procedures to inspect drive train retarders and their <b>components</b>
		describe procedures to test and diagnose drive train retarders and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>

## Range of Variables

**components** include: rotors, electromagnets, valves, sensors, pressure switches, potentiometers, lines, wiring, connectors, ECMs

**types of drive train retarders** include: electric, hydraulic

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment include:** pressure gauges, electronic service tools, multimeters, manufacturer-specific equipment

**hazards** include: moving parts, heat, pressurized fluids

**symptoms of problems** include: weak performance, intermittent operation, leaks, noises

## E-27.03 Repairs drive train retarders

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	no	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
E-27.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
E-27.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
E-27.03.03P	update software	software is updated according to <b>manufacturers' service information</b>
E-27.03.04P	rebuild drive train retarder <b>components</b>	drive train retarder <b>components</b> are rebuilt to <b>manufacturers' service information</b>
E-27.03.05P	repair drive train retarder <b>components</b>	drive train retarder <b>components</b> are repaired according to <b>manufacturers' service information</b>
E-27.03.06P	verify repairs	repairs are verified they meet <b>manufacturers' service information</b> by performing road test
E-27.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: electronic service tools, multimeters, manufacturer-specific equipment  
**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: rotors, electromagnets, valves, sensors, pressure switches, potentiometers, lines, wiring, connectors, ECMs

### Knowledge

	Learning Outcomes	Learning Objectives
E-27.03.01L	demonstrate knowledge of drive train retarders, their <b>components</b> , characteristics, applications and operation	identify <b>types of drive train retarders</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of drive train retarders and their <b>components</b>
		interpret information pertaining to drive train retarders found in <b>manufacturers' service information</b>

E-27.03.02L	demonstrate knowledge of procedures to repair drive train retarders and their <b>components</b>	identify <b>tools and equipment</b> used to repair drive train retarders and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to drive train retarders and their <b>components</b>
		describe procedures to remove, replace, and repair drive train retarders and their <b>components</b>
		describe procedures to perform software updates

### Range of Variables

**components** include: rotors, electromagnets, valves, sensors, pressure switches, potentiometers, lines, wiring, connectors, ECMs

**types of drive train retarders** include: electric, hydraulic

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: electronic service tools, multimeters, manufacturer-specific equipment

**hazards** include: moving parts, heat, pressurized fluids, sharp edges, pinch/crush points, electric and electromagnetic hazards

# Major Work Activity F

## Services, diagnoses and repairs steering, chassis/frames, suspensions, tires, wheels and hubs

### Task F-28 Services, diagnoses and repairs steering systems

#### Task Descriptor

Steering systems are designed to allow the driver to control the direction of the vehicle by turning the front wheels.

Truck and transport mechanics diagnose, service and repair steering systems and components in order to ensure the safe and correct operation of the vehicle.

#### F-28.01 Services steering systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
F-28.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-28.01.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
F-28.01.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
F-28.01.04P	measure <b>components</b>	<b>components</b> are measured for end play to determine if they meet <b>manufacturers' service information</b> and jurisdictional requirements
F-28.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b> and fleet/owner maintenance schedule to minimize breakdowns



F-28.01.05P	recycle or dispose of <b>consumables</b>	<b>consumables</b> are recycled or disposed of according to jurisdictional regulations
F-28.01.06P	lubricate <b>components</b>	<b>components</b> are lubricated according to <b>manufacturers' service information</b>
F-28.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: king pins, drag links, steering boxes, pitman arms, hydraulic cylinders, tie rods, power steering components, steering columns

**components** (to be measured) include: king pins, drag links, tie rods

**consumables** include: oil, filters

**components** (to be lubricated) include: tie rods, king pins, u-joints

Knowledge		
	Learning Outcomes	Learning Objectives
F-28.01.01L	demonstrate knowledge of steering systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>types of steering systems</b> and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of steering systems and their <b>components</b>
		interpret information pertaining to steering systems found in <b>manufacturers' service information</b>
		describe primary and secondary steering systems
		describe <b>steering geometry and alignment</b>
F-28.01.02L	demonstrate knowledge of procedures to service steering systems and their <b>components</b> and <b>consumables</b>	identify tools and equipment used to service steering systems, their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to steering systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to inspect steering systems and their <b>components</b> and <b>consumables</b>

		describe procedures to measure steering system <b>components</b>
		describe procedures to lubricate steering system <b>components</b>
		describe procedures to remove, replace, recycle and dispose of steering system <b>consumables</b>
F-28.01.03L	demonstrate knowledge of inspection tolerances to jurisdictional requirements	identify inspection tolerances to jurisdictional requirements
F-28.01.04L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposing of steering system <b>consumables</b>	identify and interpret standards and regulations pertaining to recycling and disposing of steering system <b>consumables</b>
F-28.01.05L	demonstrate knowledge of emerging technologies and practices pertaining to autonomous steering systems	identify technologies that address risk and reduce accidents, and describe their characteristics and applications

## Range of Variables

**components** include: king pins, drag links, steering boxes, pitman arms, hydraulic cylinders, tie rods, power steering components, steering columns

**consumables** include: oil, filters

**types of steering systems** include: integral, linkage, rack and pinion

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**steering geometry and alignment** includes: caster, camber, toe

**hazards** include: fluid under pressure, pinch/crush points

## F-28.02 Diagnoses steering systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-28.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
F-28.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
F-28.02.03P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
F-28.02.04P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis

F-28.02.05P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
F-28.02.06P	perform <b>tests</b>	<b>tests</b> are performed on <b>components</b> to assess for wear, damage and defects using <b>tools and equipment</b>
F-28.02.07P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected pressure values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected pressure values to verify diagnosis
F-28.02.08P	perform failure analysis	failure analysis is performed to determine root cause of failure
F-28.02.09P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
F-28.02.10P	interpret tire wear patterns	tire wear patterns are interpreted
F-28.02.11P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: darting, drifting, hard steering, soft steering, oil leaks

**tools and equipment** include: pressure gauges, hydraulic pressure analyzers, dial indicators, pry bars, alignment tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: looking for leaks, feeling for vibrations during road testing, visually inspecting steering components

**tests** include: performance, pressure, flow

**components** include: king pins, drag links, steering boxes, pitman arms, hydraulic cylinders, tie rods, power steering components

**next steps** include: repairs, component replacement or adjustment

Knowledge		
	Learning Outcomes	Learning Objectives
F-28.02.01L	demonstrate knowledge of steering systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of steering systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of steering systems and their <b>components</b>
		interpret information pertaining to steering systems found in <b>manufacturers' service information</b>
		describe primary and secondary steering systems
		describe <b>steering geometry and alignment</b>

F-28.02.02L	demonstrate knowledge of procedures to diagnose steering systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose steering systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to steering systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to inspect steering systems and their <b>components</b>
		describe procedures to test steering systems and their <b>components</b>
		describe procedures to diagnose steering systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify common <b>faults</b> found while diagnosing steering systems
F-28.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to autonomous steering systems	identify technologies that address risk and reduce accidents, and describe their characteristics and applications

## Range of Variables

**components** include: king pins, drag links, steering boxes, pitman arms, hydraulic cylinders, tie rods, power steering components

**types of steering systems** include: integral, linkage, rack and pinion

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**steering geometry and alignment** include: caster, camber, toe

**tools and equipment** include: pressure gauges, hydraulic pressure analyzers, dial indicators, pry bars, alignment tools

**hazards** include: fluid under pressure, pinch/crush points

**symptoms of problems** include: darting, drifting, hard steering, soft steering, oil leaks

**faults** include: tire wear, bent tie rods, worn drag link

## F-28.03 Repairs steering systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-28.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-28.03.02P	release or isolate stored energy	stored energy is released or isolated according to <b>manufacturers' service information</b>
F-28.03.03P	repair or replace <b>components</b>	<b>components</b> are repaired or replaced according to <b>manufacturers' service information</b>
F-28.03.04P	rebuild <b>components</b>	<b>components</b> are rebuilt according to <b>manufacturers' service information</b>
F-28.03.05P	adjust <b>components</b>	<b>components</b> are adjusted to ensure operation of <b>components</b> and equipment
F-28.03.06P	verify repairs	repairs are verified using <b>methods</b>
F-28.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be repaired or replaced) include: steering boxes, pumps, hoses, lines, seals, u-joints, reservoirs

**components** (to be rebuilt) include: power steering box, hydraulic cylinders

**components** (to be adjusted) include: poppet valves, pitman arms, worm gear, tie rod, casters

**methods** include: road testing, front end alignments, load testing, sensory observations

### Knowledge

	Learning Outcomes	Learning Objectives
F-28.03.01L	demonstrate knowledge of steering systems, their <b>components</b> , characteristics, applications and operation	identify <b>types of steering systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of steering systems and their <b>components</b>
		interpret information pertaining to steering systems found in <b>manufacturers' service information</b>

		describe primary and secondary steering systems
		describe <b>steering geometry and alignment</b>
F-28.03.02L	demonstrate knowledge of procedures to repair steering systems and their <b>components</b>	identify tools and equipment used to repair steering systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to steering systems and their <b>components</b>
		describe procedures to release or isolate stored energy
		describe procedures to remove, replace, rebuild, adjust and repair steering system <b>components</b>
F-28.03.03L	demonstrate knowledge to verify repairs	identify industry standards pertaining to verification of repairs
F-28.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to autonomous steering systems	identify technologies that address risk and reduce accidents, and describe their characteristics and applications

## Range of Variables

**components** include: king pins, drag links, steering boxes, pitman arms, hydraulic cylinders, pumps, hoses, lines, seals, u-joints, reservoirs, poppet valves, worm gear, tie rod, casters

**types of steering systems** include: integral, linkage, rack and pinion

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**steering geometry and alignment** includes: caster, camber, toe

**hazards** include: fluid under pressure, pinch/crush points

## Task F-29 Services, diagnoses and repairs chassis/frames

### Task Descriptor

The purpose of the chassis/frame is to fasten all the vehicle components.

Truck and transport mechanics service, diagnose and repair chassis/frames to ensure vehicle integrity.

#### F-29.01 Services chassis/frames

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
F-29.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-29.01.02P	clean <b>components</b>	<b>components</b> are cleaned
F-29.01.03P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify loose mounting hardware, cracks, distortions and corrosion
F-29.01.04P	measure frame rails	frame rails are measured to confirm alignment
F-29.01.05P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: frame rails, cross-members, gussets

#### Knowledge

	Learning Outcomes	Learning Objectives
F-29.01.01L	demonstrate knowledge of chassis/frames, their <b>components</b> , characteristics, applications and operation	identify chassis/frames and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of chassis/frames and their <b>components</b>
		interpret information pertaining to chassis/frames found in <b>manufacturers' service information</b>

		identify chassis/frame fasteners
F-29.01.02L	demonstrate knowledge of procedures to service chassis/frames and their <b>components</b>	identify tools and equipment used to service chassis/frames and their <b>components</b> , and describe their applications and procedures for use
		describe procedures to clean scale and rust from chassis/frame <b>components</b>
		describe procedures to reduce corrosion and maintain structural integrity
		explain structural integrity and describe safe work practices and repairs

## Range of Variables

**components** include: frame rails, cross-members, gussets

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

## F-29.02 Diagnoses chassis/ frames

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-29.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
F-29.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
F-29.02.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
F-29.02.04P	determine diagnosis	diagnosis is determined based on evidence
F-29.02.05P	perform failure analysis	failure analysis is performed to determine root cause of failure
F-29.02.06P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>
F-29.02.07P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking



## Range of Variables

**symptoms of problems** include: tire wear, loose components

**tools and equipment** include: laser alignment tools, calipers, straight edges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: looking for cracked or damaged frames, corrosion and missing or loose hardware

**next steps** include: repairs, component replacement or adjustment

Knowledge		
	Learning Outcomes	Learning Objectives
F-29.02.01L	demonstrate knowledge of chassis/frames, their <b>components</b> , characteristics, applications and operation	identify chassis/frames and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of chassis/frames and their <b>components</b>
		interpret information pertaining to chassis/frames found in <b>manufacturers' service information</b>
		describe chassis/frame fastening systems
F-29.02.02L	demonstrate knowledge of procedures to diagnose chassis/frames and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose chassis/frames and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to chassis/frames and their <b>components</b>
		describe procedures to inspect chassis/frames and their <b>components</b>
		describe procedures to test chassis/frames and their <b>components</b>
		describe procedures to diagnose chassis/frames and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		describe common <b>faults</b> found while diagnosing chassis/frames
F-29.02.03L	demonstrate knowledge of when to recommend specialty shops	identify specialty shops responsible for advanced alignment work

## Range of Variables

**components** include: frame rails, cross-members, gussets

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: laser alignment tools, calipers, straight edges

**hazards** include: pinch/crush points

**symptoms of problems** include: tire wear, loose components

**faults** include: bending, cracking, corrosion, loose and missing fasteners

### F-29.03 Repairs chassis/frames

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
F-29.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
F-29.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
F-29.03.03P	repair and replace <b>components</b>	<b>components</b> are repaired and replaced by welding and plating according to <b>manufacturers' service information</b>
F-29.03.04P	verify repairs	repairs are verified using <b>tools and equipment</b>
F-29.03.05P	modify chassis/frame	chassis/frame is modified using <b>methods</b>
F-29.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: laser alignments, calipers, straight edges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: cross-members, gussets, frame rails

**methods** include: adding inserts, drilling frames, adjusting length

Knowledge		
	Learning Outcomes	Learning Objectives
F-29.03.01L	demonstrate knowledge of chassis/frames, their <b>components</b> , characteristics, applications and operation	identify chassis/frames and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of chassis/frames and their <b>components</b>
		interpret information pertaining to chassis/frames found in <b>manufacturers' service information</b>
		describe chassis/frame fastening systems
F-29.03.02L	demonstrate knowledge of procedures to repair chassis/frames and their <b>components</b>	identify <b>tools and equipment</b> used to repair chassis/frames and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to chassis/frames and their <b>components</b>
		describe procedures to remove, replace, modify and repair chassis/frames and their <b>components</b>
F-29.03.03L	demonstrate knowledge of welding training and certification requirements to modify or repair chassis/frame	identify training and certification requirements to weld modifications or repairs to chassis/frame

### Range of Variables

**components** include: cross-members, gussets, frame rails

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: laser alignments, calipers, straight edges

**hazards** include: pinch/crush points

## Task F-30 Services, diagnoses and repairs suspensions

### Task Descriptor

Suspensions distribute load throughout the frame and withstand road hazards by absorbing energy. Truck and transport mechanics service, diagnose and repair suspensions to ensure smooth driving conditions.

#### F-30.01 Services suspensions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
F-30.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-30.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
F-30.01.03P	perform sensory inspections	sensory inspections of suspension are performed to identify worn, damaged and defective <b>components</b>
F-30.01.04P	measure <b>components</b>	<b>components</b> are measured for ride height and bushings for excessive play to determine if they meet <b>manufacturers' service information</b>
F-30.01.05P	release stored energy	stored energy is released by draining air tank and spring tension
F-30.01.06P	adjust ride height valve	ride height valve is adjusted according to <b>manufacturers' service information</b>
F-30.01.07P	lubricate components	components are lubricated according to <b>manufacturers' service information</b>
F-30.01.08P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: bolster springs, I-beams, torque rods, ride height valves, air bags, spring hangers, shackles, saddles, shock absorbers, torsion bars, walking beams, U-bolts, leaf springs

Knowledge		
	Learning Outcomes	Learning Objectives
F-30.01.01L	demonstrate knowledge of suspensions, their <b>components</b> , characteristics, applications and operation	identify <b>types of suspensions</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of suspensions and their <b>components</b>
F-30.01.02L	demonstrate knowledge of procedures to service suspensions and their <b>components</b>	identify tools and equipment used to service suspensions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to suspensions and their <b>components</b>
		describe procedures to release stored energy
		describe procedures to inspect suspensions and their <b>components</b>
		describe procedures to clean, measure, adjust and lubricate suspension <b>components</b>

### Range of Variables

**components** include: bolster springs, I-beams, torque rods, ride height valves, air bags, spring hangers, shackles, saddles, shock absorbers, torsion bars, walking beams, U-bolts, leaf springs

**types of suspensions** include: air ride (conventional, electronically controlled), spring, solid block, combination

**hazards** include: pinch/crush points, compressed air

### F-30.02 Diagnoses suspensions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
F-30.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
F-30.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
F-30.02.03P	perform sensory inspections	sensory inspections of suspension are performed to confirm complaint and establish preliminary diagnosis

F-30.02.04P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>
F-30.02.05P	compare test results to <b>manufacturers' service information</b> or expected values	test results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
F-30.02.06P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**symptoms of problems** include: wandering, drifting, sagging, difficult steering, lack of stability

**tools and equipment** include: tape measures, soapy water, dial indicators

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
F-30.02.01L	demonstrate knowledge of suspensions, their <b>components</b> , characteristics, applications and operation	identify <b>types of suspensions</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of suspensions and their <b>components</b>
		interpret information pertaining to suspensions found in <b>manufacturers' service information</b>
		describe wear limits and load capacity
F-30.02.02L	demonstrate knowledge of procedures to diagnose suspensions and their <b>components</b>	describe <b>axle applications</b>
		identify <b>tools and equipment</b> used to diagnose suspensions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to suspensions and their <b>components</b>
		describe procedures to inspect suspensions and their <b>components</b>
		describe procedures to test suspensions and their <b>components</b>
		describe procedures to diagnose suspensions and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>

		identify common <b>faults</b> found while diagnosing suspensions
F-30.02.03L	demonstrate knowledge of inspection tolerances for rear suspension to industry requirements	identify rear suspension inspection tolerances to industry requirements

## Range of Variables

**components** include: bolster springs, I-beams, torque rods, ride height valves, air bags, spring hangers, shackles, saddles, shock absorbers, torsion bars, walking beams, U-bolts

**types of suspensions** include: air ride (conventional, electronically controlled), spring, solid block, combination

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**axle applications** include: steering, drive, auxiliary

**tools and equipment** include: tape measures, soapy water, dial indicators

**hazards** include: pinch/crush points, compressed air

**symptoms of problems** include: wandering, drifting, sagging, difficult steering, lack of stability

**faults** include: broken springs, air springs, U-bolts, leaking shocks, worn bushings

## F-30.03 Repairs suspensions

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-30.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-30.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
F-30.03.03P	repair <b>components</b>	<b>components</b> are repaired according to <b>manufacturers' service information</b>
F-30.03.04P	perform <b>adjustment procedures</b>	<b>adjustment procedures</b> are performed to ensure operation of component and equipment
F-30.03.05P	verify repairs	repairs are verified using <b>methods</b>
F-30.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be replaced) include: springs, spring guides, bushings, torque rods

**components** (to be repaired) include: air lines, air springs, leaf spring assemblies, shackles, axle stop, hangers

**adjustment procedures** include: setting ride height valves, aligning axles

**methods** include: road testing, load testing, sensory observations

Knowledge		
	Learning Outcomes	Learning Objectives
F-30.03.01L	demonstrate knowledge of suspensions, their <b>components</b> , characteristics, applications and operation	identify <b>types of suspensions</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of suspensions and their <b>components</b>
		interpret information pertaining to suspensions found in <b>manufacturers' service information</b>
F-30.03.02L	demonstrate knowledge of procedures to repair suspensions and their <b>components</b>	identify tools and equipment used to repair suspensions and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to suspensions and their <b>components</b>
		describe procedures to remove, replace, adjust and repair suspension <b>components</b>

## Range of Variables

**components** include: bolster springs, I-beams, torque rods, ride height valves, air bags, spring hangers, shackles, saddles, shock absorbers, torsion bars, walking beams, U-bolts

**types of suspensions** include: air ride (conventional, electronically controlled), spring, solid block, combination

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: pinch/crush points, compressed air, compressed springs, heavy springs



## Task F-31 Services, diagnoses and repairs hitches and couplers

### Task Descriptor

Truck and transport mechanics service, diagnose and repair hitches and couplers to ensure that trailers stay coupled to the lead vehicle in a safe manner.

#### F-31.01 Services hitches and couplers

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
F-31.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-31.01.02P	clean 5 <sup>th</sup> wheel, slide rails, pintle components and mounting components	5 <sup>th</sup> wheel, slide rails, pintle components and mounting components are cleaned before additional work is completed
F-31.01.03P	perform sensory inspections	sensory inspections of 5 <sup>th</sup> wheel and pintles are performed to identify worn, damaged or defective <b>components</b>
F-31.01.04P	measure <b>components</b>	<b>components</b> are measured for play to determine if they meet <b>manufacturers' service information</b>
F-31.01.05P	adjust 5 <sup>th</sup> wheel jaws and side rail locks	5 <sup>th</sup> wheel jaws and side rail locks are adjusted according to <b>manufacturers' service information</b>
F-31.01.06P	lubricate components	components are lubricated according to <b>manufacturers' service information</b>
F-31.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: bushings, jaws, slide rail locks, clevis pin

**components** (to be measured) include: 5<sup>th</sup> wheel plate, side rail locks, bushings, pins, jaws, pintle eye and hook

Knowledge		
	Learning Outcomes	Learning Objectives
F-31.01.01L	demonstrate knowledge of hitches and couplers, their <b>components</b> , characteristics, applications and operation	identify <b>types of hitches and couplers</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of hitches and couplers, and their <b>components</b>
		describe wear limits and load capacities of hitch and coupler <b>components</b>
F-31.01.02L	demonstrate knowledge of procedures to service hitches and couplers, and their <b>components</b>	identify tools and equipment used to service hitches and couplers, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to hitches and couplers, and their <b>components</b>
		describe procedures to inspect hitches and couplers, and their <b>components</b>
		describe procedures to clean, measure, lubricate and adjust hitch and coupler <b>components</b>
F-31.01.03L	demonstrate knowledge of inspection requirements pertaining to measurements and wear	identify inspection requirements pertaining to measurements and wear

### Range of Variables

**components** include: bushings, jaws, slide rail locks, clevis pin

**types of hitches and couplers** include: pintle hitch, 5<sup>th</sup> wheel hitch, ball hitch

**hazards** include: sharp edges, pinch/crush points

## F-31.02 Diagnoses hitches and couplers

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-31.02.01P	identify <b><i>symptoms of problems</i></b>	<b><i>symptoms of problems</i></b> are identified by consulting with customer or operator
F-31.02.02P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
F-31.02.03P	perform sensory inspections	sensory inspections of hitches and couplers are performed to confirm complaint and establish preliminary diagnosis
F-31.02.04P	perform <b><i>tests</i></b>	<b><i>tests</i></b> are performed to assess components for wear, damage and defects
F-31.02.05P	test hitch and coupler operation	hitch and coupler operation are tested
F-31.02.06P	compare <b><i>test</i></b> results to <b><i>manufacturers' service information</i></b> or expected values	<b><i>test</i></b> results are compared to <b><i>manufacturers' service information</i></b> or expected values to verify diagnosis
F-31.02.07P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

***symptoms of problems*** include: excess slack, noises, difficulty opening or closing, difficulty steering

***tools and equipment*** include: king pin tool, wear plate (for tolerances)

***manufacturers' service information*** include: maintenance schedule, specifications, recommendations, procedures, standards

***tests*** include: testing for play, wear, function

### Knowledge

	Learning Outcomes	Learning Objectives
F-31.02.01L	demonstrate knowledge of hitches and couplers, their <b><i>components</i></b> , characteristics, applications and operation	identify <b><i>types of hitches and couplers</i></b> and their <b><i>components</i></b> , and describe their characteristics and applications
		describe operating principles of hitches and couplers, and their <b><i>components</i></b>
		interpret tolerance information pertaining to hitches and couplers

		describe wear limits and load capacities of hitch and coupler <b>components</b>
F-31.02.02L	demonstrate knowledge of procedures to diagnose hitches and couplers, and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose hitches and couplers, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to hitches and couplers and their <b>components</b>
		describe procedures to inspect hitches and couplers, and their <b>components</b>
		describe procedures to test hitches and couplers, and their <b>components</b>
		describe procedures to diagnose hitches and couplers, and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>

## Range of Variables

**components** include: bushings, jaws, slide rail locks, clevis pin

**types of hitches and couplers** include: pintle hitch, 5<sup>th</sup> wheel hitch, ball hitch

**tools and equipment** include: king pin tool, wear plate (for tolerances)

**hazards** include: sharp edges, pinch/crush points

**symptoms of problems** include: excess slack, noises, difficulty opening or closing, difficulty steering

## F-31.03 Repairs hitches and couplers

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-31.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
F-31.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
F-31.03.03P	repair and rebuild <b>5<sup>th</sup> wheel components</b>	<b>5<sup>th</sup> wheel components</b> are repaired and rebuilt by using rebuild kits according to <b>manufacturers' service information</b>
F-31.03.04P	adjust 5 <sup>th</sup> wheel	5 <sup>th</sup> wheel is adjusted according to <b>manufacturers' service information</b> to ensure operation of components and equipment

F-31.03.05P	verify repairs	repairs are verified using <b>methods</b>
F-31.03.06P	lubricate components	components are lubricated according to <b>manufacturers' service information</b>
F-31.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: jaws, 5<sup>th</sup> wheels, springs, pins, pintle eye and hook

**5<sup>th</sup> wheel components** include: jaws, pins, springs, bushings, mounting components

**methods** include: coupling, uncoupling

Knowledge		
	Learning Outcomes	Learning Objectives
F-31.03.01L	demonstrate knowledge of hitches and couplers, their <b>components</b> , characteristics, applications and operation	identify <b>types of hitches and couplers</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of hitches and couplers, and their <b>components</b>
		describe wear limits and load capacities of hitch and coupler <b>components</b>
F-31.03.02L	demonstrate knowledge of procedures to repair hitches and couplers, and their <b>components</b>	identify tools and equipment used to repair hitches and couplers, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to hitches and couplers, and their <b>components</b>
		describe procedures to remove, replace, adjust, lubricate and repair hitches and couplers, and their <b>components</b>

## Range of Variables

**components** include: jaws, 5<sup>th</sup> wheels, springs, pins, pintle eye and hook

**types of hitches and couplers** include: pintle hitch, 5<sup>th</sup> wheel hitch, ball hitch

**hazards** include: sharp edges, pinch/crush points

## Task F-32 Services, diagnoses and repairs tires, wheels and hubs

### Task Descriptor

Truck and transport mechanics service, diagnose and repair tires, wheels and hubs to ensure that the truck performs properly on the road.

#### F-32.01 Services tires, wheels and hubs

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
F-32.01.01P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
F-32.01.02P	perform sensory inspections	sensory inspections are performed to identify <b><i>worn, damaged and defective components</i></b>
F-32.01.03P	perform <b><i>measurements on tire components</i></b>	<b><i>measurements on tire components</i></b> are performed to determine if they meet <b><i>manufacturers' service information</i></b>
F-32.01.04P	perform <b><i>measurements on hub components</i></b>	<b><i>measurements on hub components</i></b> are performed to determine if they meet <b><i>manufacturers' service information</i></b> and jurisdictional requirements
F-32.01.05P	torque wheel nuts	wheel nuts are torqued according to <b><i>manufacturers' service information</i></b>
F-32.01.06P	release stored energy	stored energy is released by draining air from tires
F-32.01.07P	remove and replace consumables	consumables are removed and replaced according to <b><i>manufacturers' service information</i></b>
F-32.01.08P	recycle and dispose of consumables	consumables are recycled and disposed of according to jurisdictional regulations
F-32.01.09P	adjust tire pressure	tire pressure is adjusted according to <b><i>manufacturers' service information</i></b>
F-32.01.10P	identify mismatched tires	mismatched tires are identified by casing and tread depth
F-32.01.11P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: dial indicators, torque wrenches, air gauges, tire pressure/heat warning devices, tread depth gauges, tire pressure gauge, inflation tool, sockets, tire irons

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**worn, damaged and defective components** include: oil leaks from hubs, air leaks from tires, tire wear, damaged retreading, cracked rims, broken studs, worn locks, worn spacers

**measurements on tire components** include: tread depth for wear, air pressure for air leaks

**measurements on hub components** include: bearing end play, alignment of pilot to rim

Knowledge		
	Learning Outcomes	Learning Objectives
F-32.01.01L	demonstrate knowledge of tires, their <b>components</b> , characteristics, applications and operation	identify <b>types of tires</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of tires and their <b>components</b>
		describe tire load ranges, pressures, profiles and sizes
		describe steering and drive tires
F-32.01.02L	demonstrate knowledge of wheels, their <b>components</b> , characteristics, applications and operation	identify <b>types of wheels</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of wheels and their <b>components</b>
F-32.01.03L	demonstrate knowledge of hubs, their <b>components</b> , consumables, characteristics, applications and operation	identify <b>types of hubs</b> and their <b>components</b> and consumables, and describe their characteristics and applications
		describe operating principles of hubs and their <b>components</b>
F-32.01.04L	demonstrate knowledge of procedures to service tires, wheels and hubs, and their <b>components</b>	identify <b>tools and equipment</b> used to service tires, wheels and hubs, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to inflation and removal of tires
		describe procedures to release stored energy
		describe procedures to inspect tires, wheels and hubs, and their <b>components</b>
		describe procedures to measure tire and hub <b>components</b>
		describe procedures to service tire, wheel and hub <b>components</b>

		describe procedures to remove, replace, recycle and dispose of hub consumables
		describe torque values according to <b>manufacturers' service information</b>
		identify tires and materials that can be reconditioned, reused or recycled
F-32.01.05L	demonstrate knowledge of training requirements to remove, inspect and mount tires, wheels and hubs	identify training requirements to remove, inspect and mount tires, wheels and hubs
F-32.01.06L	demonstrate knowledge of regulatory requirements pertaining to inspection and mounting of tires, wheels and hubs	identify and interpret standards and regulations pertaining to inspection and mounting of tires, wheels and hubs
F-32.01.07L	demonstrate knowledge of air pressure monitoring and air regulating systems	describe operation of air pressure monitoring and air regulating systems

## Range of Variables

**components** (tires) include: belts, tread, tubes, sidewall

**types of tires** include: radial, bias

**components** (wheels) include: rims, spacers, wedges, valve stems

**types of wheels** include: aluminum, steel, multi-piece rims

**components** (hubs) include: studs, nuts, spacers

**types of hubs** include: spoked, hub pilot, stud pilot

**tools and equipment** include: dial indicators, torque wrenches, air gauges, tire pressure/heat warning devices, tread depth gauges, tire pressure gauge, inflation tool, sockets, tire irons

**hazards** include: spoke wheels, wedges, pressurized air, over inflation

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

## F-32.02 Diagnoses tires, wheels and hubs

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-32.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
F-32.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
F-32.02.03P	perform sensory inspections	sensory inspections are performed to confirm complaint and establish preliminary diagnosis



F-32.02.04P	perform diagnostic procedures	diagnostic procedures are performed by following <b>manufacturers' service information</b>
F-32.02.05P	measure components for wear, damage and defects	components are measured for wear, damage and defects
F-32.02.06P	compare test results to <b>manufacturers' service information</b> or expected values	test results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
F-32.02.07P	perform failure analysis	failure analysis is performed to determine root cause of failure
F-32.02.08P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**symptoms of problems** include: wandering, drifting, sagging, difficult steering, lack of stability, shaking, wheel hop, shimmy, harmonic and dynamic vibrations or movement

**tools and equipment** include: dial indicators, torque wrenches, air gauges, tire pressure/heat warning devices, tread depth gauges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

Knowledge		
	Learning Outcomes	Learning Objectives
F-32.02.01L	demonstrate knowledge of tires, their <b>components</b> , characteristics, applications and operation	identify <b>types of tires</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of tires and their <b>components</b>
		describe tire load ranges, pressures, profiles and sizes
		describe steering and drive tires
F-32.02.02L	demonstrate knowledge of wheels, their <b>components</b> , characteristics, applications and operation	identify <b>types of wheels</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of wheels and their <b>components</b>
F-32.02.03L	demonstrate knowledge of hubs, their <b>components</b> , characteristics, applications and operation	identify <b>types of hubs</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of hubs and their <b>components</b>
F-32.02.04L	demonstrate knowledge of procedures to diagnose tires, wheels and hubs, and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose tires, wheels and hubs, and their <b>components</b> , and describe their applications and procedures for use

		identify <b>hazards</b> and describe safe work practices pertaining to tires, wheels and hubs, and their <b>components</b>
		interpret information pertaining to tires, wheels and hubs, and their <b>components</b> found in <b>manufacturers' service information</b>
		describe procedures to inspect tires, wheels and hubs, and their <b>components</b>
		describe procedures to test tires, wheels and hubs, and their <b>components</b>
		describe procedures to diagnose tires, wheels and hubs, and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
F-32.02.05L	demonstrate knowledge of jurisdictional regulations regarding out-of-service specifications	describe jurisdictional regulations regarding out-of-service specifications

## Range of Variables

**components** (tires) include: belts, tread, sidewall

**types of tires** include: radial, bias

**components** (wheels) include: rims, spacers, wedges, valve stems

**types of wheels** include: aluminum, steel, multi-piece rims

**components** (hubs) include: studs, nuts, spacers

**types of hubs** include: spoked, hub pilot, stud pilot

**tools and equipment** include: dial indicators, torque wrenches, air gauges, tire pressure/heat warning devices, tread depth gauges

**hazards** include: spoke wheels, wedges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**symptoms of problems** include: wandering, drifting, sagging, difficult steering, lack of stability, shaking, wheel hop, shimmy, harmonic and dynamic vibrations or movement

## F-32.03 Repairs tires, wheels and hubs

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
F-32.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
F-32.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
F-32.03.03P	rebuild components	components are rebuilt by replacing bearings and races according to <b>manufacturers' service information</b>
F-32.03.04P	repair <b>components</b>	<b>components</b> are repaired by replacing seals, bearings, races, patches and plugs, according to <b>manufacturers' service information</b>
F-32.03.05P	adjust bearing and oil level	bearing and oil level are adjusted according to <b>manufacturers' service information</b> to ensure operation of components and equipment
F-32.03.06P	adjust air pressure, run-out and torque on spoke wheels	air pressure, run-out and torque are adjusted on spoke wheels according to <b>manufacturers' service information</b>
F-32.03.07P	verify repairs	repairs are verified using <b>methods</b> according to <b>manufacturers' service information</b>
F-32.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: dial indicators, torque wrenches, air gauges, tire pressure/heat warning devices, tread depth gauges

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be replaced) include: tires, rims, bearings, studs

**components** (to be repaired) include: tire assemblies, hub assemblies

**methods** include: wheel alignment, road testing, checking for end play

## Knowledge

Learning Outcomes		Learning Objectives
F-32.03.01L	demonstrate knowledge of tires, their <b>components</b> , characteristics, applications and operation	identify <b>types of tires</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of tires and their <b>components</b>
		describe tire load ranges, pressures, profiles and sizes
		describe steering and drive tires
F-32.03.02L	demonstrate knowledge of wheels, their <b>components</b> , characteristics, applications and operation	identify <b>types of wheels</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of wheels and their <b>components</b>
F-32.03.03L	demonstrate knowledge of hubs, their <b>components</b> , characteristics, applications and operation	identify <b>types of hubs</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of hubs and their <b>components</b>
F-32.03.04L	demonstrate knowledge of procedures to repair tires, wheels and hubs, and their <b>components</b>	identify <b>tools and equipment</b> used to repair tires, wheels and hubs, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to tires, wheels and hubs, and their <b>components</b>
		interpret information pertaining to tires, wheels and hubs, and their <b>components</b> found in <b>manufacturers' service information</b>
		describe procedures to remove, replace, rebuild, adjust and repair tires, wheels and hubs, and their <b>components</b>
F-32.03.05L	demonstrate knowledge of training requirements to remove, inspect and mount tires, wheels and hubs	identify training requirements to remove, inspect and mount tires, wheels and hubs
F-32.03.06L	demonstrate knowledge of inspection requirements pertaining to tire size	identify inspection requirements pertaining to tire size

## Range of Variables

**components** (tires) include: belts, tread, sidewall

**types of tires** include: radial, bias

**components** (wheels) include: rims, spacers, wedges, valve stems

**types of wheels** include: aluminum, steel, multi-piece rims

**components** (hubs) include: studs, nuts, spacers

**types of hubs** include: spoked, hub pilot, stud pilot

**tools and equipment** include: dial indicators, torque wrenches, air gauges, tire pressure/heat warning devices, tread depth gauges

**hazards** include: spoke wheels, wedges, pinch/crush points, pressurized air

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

# Major Work Activity G

## Services, diagnoses and repairs cabs

### Task G-33 Services, diagnoses and repairs interior cab components

#### Task Descriptor

The vehicle is made up of interior components surrounding the occupants. Service, diagnostics and repair of components as well as routine maintenance is a necessity.

#### G-33.01 Services interior cab components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
G-33.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
G-33.01.02P	clean, adjust and lubricate <b>components</b>	<b>components</b> are cleaned, adjusted and lubricated according to <b>manufacturers' service information</b>
G-33.01.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
G-33.01.04P	release stored energy	stored energy is released by disconnecting power sources, draining air reservoirs and allowing capacitors to discharge in SRS modules
G-33.01.04P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: scan tools, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be cleaned, adjusted and lubricated) include: brake, throttle and clutch pedal pivot points, bed lifts, seat tracks, steering columns, shift mechanisms

**components** include: pedals, seats, seat belts, safety equipment, gauges, warning devices, driver controls (lighting, horns, switches), wheelchair accessories, SRSs (air bags), pneumatics, air-powered accessories, side windows, electrical accessories, cabinetry, safety netting, bunk air conditioning, heating and lighting systems

Knowledge		
	Learning Outcomes	Learning Objectives
G-33.01.01L	demonstrate knowledge of interior cab <b>components</b> , their characteristics, applications and operation	identify interior cab <b>components</b> , and describe their characteristics and applications
		describe operating principles of interior cab <b>components</b>
		interpret information pertaining to interior cab <b>components</b> found in <b>manufacturers' service information</b>
G-33.01.02L	demonstrate knowledge of procedures to service interior cab <b>components</b>	identify <b>tools and equipment</b> used to service interior cab <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to interior cab <b>components</b>
		describe procedures to release stored energy
		describe procedures to inspect interior cab <b>components</b>
		describe procedures to clean, adjust and lubricate interior cab <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
G-33.01.03L	demonstrate knowledge of manufacturer training requirements pertaining to SRS	identify manufacturer training requirements to service SRS
G-33.01.04L	demonstrate knowledge of regulatory requirements pertaining to SRS	identify and interpret standards and regulations pertaining to SRS

G-33.01.05L	demonstrate knowledge of <b>technologies</b> and practices pertaining to interior cab <b>components</b>	identify <b>technologies</b> and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify other emerging technologies

## Range of Variables

**components** include: pedals, seats, seat belts, safety equipment, gauges, warning devices, driver controls (lighting, horns, switches), wheelchair accessories, SRSs (air bags), pneumatics, air-powered accessories, side windows, electrical accessories, cabinetry, safety netting, bunk air conditioning, heating and lighting systems

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: scan tools, electronic service tools

**hazards** include: shocks, pressure injection injuries, explosive SRS, pinch/crush points, frost bite and burns from HVAC systems

**technologies** include: engine circulation heaters, cab air heaters, idle-free systems (auxiliary power unit [APU]), fuel cell APU, solar

## G-33.02 Diagnoses interior cab components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
G-33.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
G-33.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
G-33.02.03P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
G-33.02.04P	perform diagnostic procedures	diagnostic procedures are performed by following <b>manufacturers' service information</b> to determine failure
G-33.02.05P	interpret diagnostic results	diagnostic results are interpreted according to <b>manufacturers' service information</b> to determine <b>next steps</b>



## Range of Variables

**symptoms of problems** include: sticking pedals; air leak on seat; malfunctioning window controls; stiff, loose or binding steering column

**tools and equipment** include: electronic service tools, force meters, temperature measuring devices, multimeters, hand tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: pedals, seats, seat belts, safety equipment, gauges, warning devices, driver controls (lighting, horns, switches), wheelchair accessories, SRSs (air bags), pneumatics, air-powered accessories, side windows, electrical accessories, cabinetry, safety netting, bunk air conditioning, heating and lighting systems

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
G-33.02.01L	demonstrate knowledge of interior cab <b>components</b> , their characteristics, applications and operation	identify interior cab <b>components</b> , and describe their characteristics and applications
		describe operating principles of interior cab <b>components</b>
		interpret information pertaining to interior cab <b>components</b> found in <b>manufacturers' service information</b>
G-33.02.02L	demonstrate knowledge of procedures to diagnose interior cab <b>components</b>	identify <b>tools and equipment</b> used to diagnose interior cab <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to interior cab <b>components</b>
		describe procedures to inspect interior cab <b>components</b>
		describe procedures to test interior cab <b>components</b>
		describe procedures to diagnose interior cab <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify materials that can be reconditioned, reused or recycled
G-33.02.03L	demonstrate knowledge of manufacturer training requirements pertaining to SRS	identify practices that reduce material waste
		identify manufacturer training requirements to diagnose SRS

G-33.02.04L	demonstrate knowledge of <b>technologies</b> and practices pertaining to interior cab <b>components</b>	identify <b>technologies</b> and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify other emerging technologies

## Range of Variables

**components** include: pedals, seats, seat belts, safety equipment, gauges, warning devices, driver controls (lighting, horns, switches), wheelchair accessories, SRSs (air bags), pneumatics, air-powered accessories, side windows, electrical accessories, cabinetry, safety netting, bunk air conditioning, heating and lighting systems

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: electronic service tools, force meters, temperature measuring devices, multimeters, hand tools

**hazards** include: shocks, pressure injection injuries, explosive SRS, pinch/crush points, frost bite and burns from HVAC systems

**symptoms of problems** include: sticking pedals; air leak on seat; malfunctioning window controls; stiff, loose or binding steering column

**technologies** include: engine circulation heaters, cab air heaters, idle-free systems (APU), fuel cell APU, solar

## G-33.03 Repairs interior cab components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
G-33.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
G-33.03.02P	repair and replace <b>components</b>	<b>components</b> are repaired and replaced according to <b>manufacturers' service information</b>
G-33.03.03P	adjust <b>components</b>	<b>components</b> are adjusted according to <b>manufacturers' service information</b>

G-33.03.04P	verify repairs	repairs are verified under normal operating conditions to ensure it is within <b>manufacturers' service information</b>
G-33.03.05P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: electronic service tools, force meters, temperature measuring devices, multimeters, hand tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be repaired and replaced) include: door panels, seat belts, seats, window regulators, motors, switches, dash valves

**components** (to be adjusted) include: brakes, clutches, brake switches

Knowledge		
	Learning Outcomes	Learning Objectives
G-33.03.01L	demonstrate knowledge of interior cab <b>components</b> , their characteristics, applications and operation	identify interior cab <b>components</b> , and describe their characteristics and applications
		describe operating principles of interior cab <b>components</b>
		interpret information pertaining to interior cab <b>components</b> found in <b>manufacturers' service information</b>
G-33.03.02L	demonstrate knowledge of procedures to repair interior cab <b>components</b>	identify <b>tools and equipment</b> used to repair interior cab <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to interior cab <b>components</b>
		describe procedures to remove, replace, adjust and repair interior cab <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
G-33.03.03L	demonstrate knowledge of manufacturer training requirements pertaining to SRS	identify manufacturer training requirements to repair SRS

G-33.03.04L	demonstrate knowledge of <b>technologies</b> and practices pertaining to interior cab <b>components</b>	identify <b>technologies</b> and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify other emerging technologies

## Range of Variables

**components** include: door panels, seat belts, seats, window regulators, motors, switches, dash valves  
**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: electronic service tools, force meters, temperature measuring devices, multimeters, hand tools

**hazards** include: shocks, pressure injection injuries, explosive SRS, pinch/crush points, frost bite and burns from HVAC systems

**technologies** include: engine circulation heaters, cab air heaters, idle-free systems (APU), fuel cell APU, solar

## Task G-34 Services, diagnoses and repairs exterior cab components

### Task Descriptor

The vehicle is made up of exterior components surrounding the occupants. Service, diagnostics and repair of components as well as routine maintenance is a necessity.

### G-34.01 Services exterior cab components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
G-34.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
G-34.01.02P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
G-34.01.03P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>

G-34.01.04P	clean, lubricate and adjust exterior cab components	exterior cab components are cleaned, lubricated and adjusted according to <b>manufacturers' service information</b>
G-34.01.05P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
G-34.01.05P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: headlight adjusting tools, hand tools, multimeters, test lights, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: windshields, wipers, mirrors, door handles, door hinges, door strikers, steps, wind deflectors, engine hood cables, lockdown straps, mouldings, fenders, horns, tilt mechanisms, hood pivot points, hood-assist cylinders, cab suspension

**consumables** include: lights, wipers, washer fluids, cab air filters

Knowledge		
	Learning Outcomes	Learning Objectives
G-34.01.01L	demonstrate knowledge of exterior cab <b>components</b> and <b>consumables</b> , their characteristics, applications and operation	identify exterior cab <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of exterior cab <b>components</b> and <b>consumables</b>
G-34.01.02L	demonstrate knowledge of procedures to service exterior cab <b>components</b> and <b>consumables</b>	identify <b>tools and equipment</b> used to service exterior cab <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to exterior cab <b>components</b> and <b>consumables</b>
		describe procedures to inspect exterior cab <b>components</b> and <b>consumables</b>
		describe procedures to remove, replace, recycle and dispose of <b>consumables</b>
		describe procedures to clean, lubricate and adjust exterior cab components
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste

G-34.01.03L	demonstrate knowledge of emerging technologies and practices pertaining to exterior cab <b>components</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify technologies in aerodynamics that address fuel economy, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: windshields, wipers, mirrors, door handles, door hinges, door strikers, steps, wind deflectors, engine hood cables, lockdown straps, mouldings, fenders, horns, tilt mechanisms, hood pivot points, hood-assist cylinders, cab suspension

**consumables** include: lights, wipers, washer fluids, cab air filters

**tools and equipment** include: headlight adjusting tools, hand tools, multimeters, test lights, electronic service tools

**hazards** include: pinch/crush points, sharp edges, noises, falls, pressurized air

## G-34.02 Diagnoses exterior cab components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
G-34.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
G-34.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
G-34.02.03P	perform sensory inspections	perform sensory inspections of <b>components</b> to identify <b>defects</b>
G-34.02.04P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b>
G-34.02.05P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
G-34.02.06P	perform failure analysis	failure analysis is performed to determine root cause of failure

G-34.02.07P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
G-34.02.08P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: cab tilted, rough ride, loose components, doors not functional, noises, poor visibility

**tools and equipment** include: hand tools, multimeters, test lights, electronic service tools, headlight adjusting tools

**manufacturers' service information** include: specifications, recommendations, procedures, standards, logic diagrams

**components** include: windshields, wipers, mirrors, door handles, door hinges, door strikers, steps, wind deflectors, engine hood cables, lockdown straps, mouldings, fenders, horns, tilt mechanisms, hood pivot points, hood-assist cylinders, cab suspension

**defects** include: cracks in cab frame, loose fasteners and fairings, worn and damaged bushings, leaking or damaged shocks and valves, inoperative windshield wipers, damaged glass, inoperative horns, failed air bags

**tests** include: checking cab ride height, checking electronic control parameters

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
G-34.02.01L	demonstrate knowledge of exterior cab <b>components</b> , their characteristics, applications and operation	identify exterior cab <b>components</b> , and describe their characteristics and applications
		describe operating principles of exterior cab <b>components</b>
		interpret information pertaining to exterior cab <b>components</b> found in <b>manufacturers' service information</b>
G-34.02.02L	demonstrate knowledge of procedures to diagnose exterior cab <b>components</b>	identify <b>tools and equipment</b> used to diagnose exterior cab <b>components</b> and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to exterior cab <b>components</b>
		describe procedures to inspect exterior cab <b>components</b>
		describe procedures to test exterior cab <b>components</b>
		describe procedures to diagnose exterior cab <b>components</b>
		describe common causes and <b>symptoms of problems</b>

		identify <b>defects</b> found while diagnosing exterior cab <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
G-34.02.03L	demonstrate knowledge of emerging technologies and practices pertaining to exterior cab <b>components</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify technologies in aerodynamics that address fuel economy, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: windshields, wipers, mirrors, door handles, door hinges, door strikers, steps, wind deflectors, engine hood cables, lockdown straps, mouldings, fenders, horns, tilt mechanisms, hood pivot points, hood-assist cylinders, cab suspension

**manufacturers' service information** include: specifications, recommendations, procedures, standards, logic diagrams

**tools and equipment** include: hand tools, multimeters, test lights, electronic service tools, headlight adjusting tools

**hazards** include: pinch/crush points, sharp edges, noises, falls, pressurized air

**symptoms of problems** include: cab tilted, rough ride, loose components, doors not functional, noises, poor visibility

**defects** include: cracks in cab frame, loose fasteners and fairings, worn and damaged bushings, leaking or damaged shocks and valves, inoperative windshield wipers, damaged glass, inoperative horns, failed air bags

## G-34.03 Repairs exterior cab components

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
G-34.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
G-34.03.02P	adjust doors, hood and cab	doors, hood and cab are adjusted to ensure operation of component and equipment



G-34.03.03P	replace and repair worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are replaced and repaired according to <b>manufacturers' service information</b>
G-34.03.04P	verify repair	repair is verified to ensure it is within <b>manufacturers' service information</b>
G-34.03.05P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: hand tools, multimeters, test lights, electronic service tools, headlight adjusting tools, glass repair tools, ride height tools, welding and cutting equipment

**manufacturers' service information** include: specifications, recommendations, procedures, standards

**components** include: windshields, wipers, mirrors, door handles, door hinges, door strikers, steps, wind deflectors, engine hood cables, lockdown straps, mouldings, fenders, horns, tilt mechanisms, hood pivot points, hood-assist cylinders, cab suspension

Knowledge		
	Learning Outcomes	Learning Objectives
G-34.03.01L	demonstrate knowledge of exterior cab <b>components</b> , their characteristics, applications and operation	identify exterior cab <b>components</b> , and describe their characteristics and applications
		describe operating principles of exterior cab <b>components</b>
G-34.03.02L	demonstrate knowledge of procedures to repair exterior cab <b>components</b>	identify <b>tools and equipment</b> used to repair exterior cab <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to exterior cab <b>components</b>
		describe procedures to remove, replace, adjust and repair exterior cab <b>components</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
G-34.03.03L	demonstrate knowledge of emerging technologies and practices pertaining to exterior cab <b>components</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify technologies in aerodynamics that address fuel economy, and describe their characteristics and applications
		identify emerging technologies pertaining to other non-green technologies

## Range of Variables

**components** include: windshields, wipers, mirrors, door handles, door hinges, door strikers, steps, wind deflectors, engine hood cables, lockdown straps, mouldings, fenders, horns, tilt mechanisms, hood pivot points, hood-assist cylinders, cab suspension

**tools and equipment** include: hand tools, multimeters, test lights, electronic service tools, headlight adjusting tools, glass repair tools, ride height tools, welding and cutting equipment

**hazards** include: pinch/crush points, sharp edges, noises, falls, burns, pressurized air

# Major Work Activity H

## Services, diagnoses and repairs trailers

### Task H-35 Services, diagnoses and repairs trailer components and accessories

#### Task Descriptor

Truck and transport mechanics must be able to service, diagnose and repair trailer components and accessories.

#### H-35.01 Services trailer components and accessories

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
H-35.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
H-35.01.02P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
H-35.01.03P	clean, lubricate and test movement of <b>components</b> and interior of trailer	<b>components</b> and interior of trailer are cleaned and lubricated according to <b>manufacturers' service information</b> , and tested for movement
H-35.01.04P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

#### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: king pins, hitches, couplers, doors, handles, bogie rails, cross members, body panels, flooring, roof, wall studs, lift axles, kick plates, landing gear (legs, feet, gearing, handles, cross tubes, brackets, bracing), refrigeration panels, electronic lift axles

Knowledge		
	Learning Outcomes	Learning Objectives
H-35.01.01L	demonstrate knowledge of trailer <b>components</b> and <b>accessories</b> , their characteristics, applications and operation	identify trailer <b>components</b> and <b>accessories</b> , and describe their characteristics and applications
		describe operating principles of trailer <b>components</b> and <b>accessories</b>
		identify required signage, lighting and reflective material for safety
		identify landing gear components, and describe their characteristics and applications
H-35.01.02L	demonstrate knowledge of procedures to service trailer <b>components</b> and <b>accessories</b>	identify tools and equipment used to service trailer <b>components</b> and <b>accessories</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to trailer <b>components</b> and <b>accessories</b>
		describe procedures to inspect trailer <b>components</b> and <b>accessories</b>
		describe procedures to clean, lubricate and test movement of trailer <b>components</b>
		identify materials that can be reconditioned, reused or recycled
H-35.01.03L	demonstrate knowledge of training and certification requirements to trailer <b>components</b> and <b>accessories</b>	identify training and certification requirements pertaining to trailer <b>components</b> and <b>accessories</b>
H-35.01.04L	demonstrate knowledge of regulatory requirements pertaining to signage, lighting and reflective materials	identify and interpret standards and regulations pertaining to signage, lighting and reflective materials
H-35.01.05L	demonstrate knowledge of emerging technologies and practices pertaining to trailer <b>components</b> and <b>accessories</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications
		identify types of tires that reduce material waste

## Range of Variables

**components** include: king pins, hitches, couplers, doors, handles, bogie rails, cross members, body panels, flooring, roof, wall studs, lift axles, kick plates, landing gear (legs, feet, gearing, handles, cross tubes, brackets, bracing), refrigeration panels, electronic lift axles

**accessories** include: canvas air chute, wind deflectors

**hazards** include: pinch/crush points, frostbite, burns, fuel spills, grease injection

## H-35.02 Diagnoses trailer components and accessories

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
H-35.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
H-35.02.02P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
H-35.02.03P	perform sensory inspections	perform sensory inspections to identify worn, damaged and defective <b>components</b>
H-35.02.04P	determine <b>faults</b>	<b>faults</b> are determined
H-35.02.05P	perform failure analysis	failure analysis is performed to determine root cause of failure
H-35.02.06P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
H-35.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

### Range of Variables

**symptoms of problems** include: loose or broken wind deflectors, bent or worn king pins, malfunctioning landing gear, malfunctioning lights

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: king pins, hitches, couplers, doors, bogie rails, cross members, body panels, flooring, roof, wall studs, lift axles, kick plates, landing gear (legs, feet, gearing, handles, cross tubes, brackets, bracing), refrigeration panels, electronic lift axles

**faults** include: wear, corrosion, overloading, loose fasteners, lack of lubrication, seized gear boxes, stripped gears, broken handles, bent legs and pads, bent and broken cross tubes

**next steps** include: repairs, component replacement or adjustment, further diagnosis

### Knowledge

	Learning Outcomes	Learning Objectives
H-35.02.01L	demonstrate knowledge of trailer <b>components</b> and <b>accessories</b> , their characteristics, applications and operation	identify trailer <b>components</b> and <b>accessories</b> , and describe their characteristics and applications
		describe operating principles of trailer <b>components</b> and <b>accessories</b>

		interpret information pertaining to trailer <b>components</b> and <b>accessories</b> found in <b>manufacturers' service information</b>
		identify required signage, lighting and reflective material for safety
		identify types of landing gear components and describe their characteristics and applications
H-35.02.02L	demonstrate knowledge of procedures to diagnose trailer <b>components</b> and <b>accessories</b>	identify tools and equipment used to diagnose trailer <b>components</b> and <b>accessories</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to trailer <b>components</b> and <b>accessories</b>
		describe procedures to inspect trailer <b>components</b> and <b>accessories</b>
		describe procedures to test trailer <b>components</b> and <b>accessories</b>
		describe procedures to diagnose trailer <b>components</b> and <b>accessories</b>
		describe common causes and <b>symptoms of problems</b>
		identify steps for failure analysis
		identify materials that can be reconditioned, reused or recycled
H-35.02.03L	demonstrate knowledge of regulatory requirements pertaining to signage, lighting and reflective materials	identify and interpret standards and regulations pertaining to signage, lighting and reflective materials
H-35.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to trailer <b>components</b> and <b>accessories</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: king pins, hitches, couplers, doors, bogie rails, cross members, body panels, flooring, roof, wall studs, lift axles, kick plates, landing gear (legs, feet, gearing, handles, cross tubes, brackets, bracing), refrigeration panels, electronic lift axles

**accessories** include: canvas air chute, wind deflectors

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: pinch/crush points, frostbite, burns, fuel spills, grease injection

**symptoms of problems** include: loose or broken wind deflectors, bent or worn king pins, malfunctioning landing gear, malfunctioning lights

## H-35.03 Repairs trailer components and accessories

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
H-35.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
H-35.03.02P	replace and repair <b>components and accessories</b>	<b>components and accessories</b> are replaced and repaired according to <b>manufacturers' service information</b>
H-35.03.03P	adjust locks and doors	locks and doors are adjusted according to <b>manufacturers' service information</b>
H-35.03.04P	rebuild <b>components</b>	<b>components</b> are rebuilt according to <b>manufacturers' service information</b>
H-35.03.05P	verify repair	repairs are verified using <b>methods</b>
H-35.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: bucking bars, rivet guns, winding bars, thermal cameras, smoke bombs  
**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components and accessories** include: king pins, hitches, couplers, doors, bogie rails, cross members, canvas air chute, body panels, flooring, roof, wall studs, lift axles, kick plate, landing gear (legs, feet, gearing, handles, cross tubes, brackets, bracing), refrigeration panels, electronic lift axles

**components** (to be rebuilt) include: floors, walls, cross members, scuff rails, gear box

**methods** include: road testing, load testing, sensory observations

### Knowledge

	Learning Outcomes	Learning Objectives
H-35.03.01L	demonstrate knowledge of trailer <b>components and accessories</b> , their characteristics, applications and operation	identify trailer <b>components and accessories</b> , and describe their characteristics and applications
		describe operating principles of trailer <b>components and accessories</b>
		interpret information pertaining to trailer <b>components and accessories</b> found in <b>manufacturers' service information</b>
		identify required signage, lighting and reflective material for safety

		identify types of landing gear components and describe their characteristics and applications
H-35.03.02L	demonstrate knowledge of procedures to repair trailer <b>components and accessories</b>	identify <b>tools and equipment</b> used to repair trailer <b>components and accessories</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to trailer <b>components and accessories</b>
		describe procedures to remove, replace, adjust, rebuild and repair trailer <b>components and accessories</b>
		identify materials that can be reconditioned, reused or recycled
H-35.03.03L	demonstrate knowledge of regulatory requirements pertaining to trailer <b>components and accessories</b>	identify codes, standards and regulations pertaining to trailer <b>components and accessories</b>
H-35.03.04L	demonstrate knowledge of regulatory requirements pertaining to signage, lighting and reflective materials	identify and interpret standards and regulations pertaining to signage, lighting and reflective materials
H-35.03.05L	demonstrate knowledge of emerging technologies and practices pertaining to trailer <b>components and accessories</b>	identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components and accessories** include: king pins, hitches, couplers, doors, bogie rails, cross members, canvas air chute, body panels, flooring, roof, wall studs, lift axles, kick plate, landing gear (legs, feet, gearing, handles, cross tubes, brackets, bracing), refrigeration panels, electronic lift axles

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: bucking bars, rivet guns, winding bars, thermal cameras, smoke bombs

**hazards** include: pinch/crush points, frostbite, burns, fuel spills, grease injection



## Task H-36 Services, diagnoses and repairs heating and refrigeration systems

### Task Descriptor

Truck and transport mechanics service, diagnose and repair fuel, charging and starting systems as part of trailer heating and refrigeration systems. Special training or licenses are required to work on refrigeration, propane heating and high-voltage systems. Specialty equipment is required for some tasks.

#### H-36.01 Services heating and refrigeration systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
H-36.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
H-36.01.02P	perform sensory inspections	sensory inspections are performed to identify worn, damaged and defective <b>components</b>
H-36.01.03P	clean or replace electrical connections on starters, alternators and batteries	electrical connections on starters, alternators and batteries are cleaned or replaced
H-36.01.04P	lubricate cleaned electrical connections	cleaned electrical connections are lubricated using dielectric grease
H-36.01.05P	adjust belt tension	belt tension is adjusted with belt tension gauge according to <b>manufacturers' service information</b>
H-36.01.06P	perform <b>preventative maintenance checks</b>	<b>preventative maintenance checks</b> are performed
H-36.01.07P	drain water from fuel tank and add stabilizer or conditioner	water from fuel tank is drained and stabilizer or conditioner is added according to seasonal requirements
H-36.01.08P	secure fuel lines	fuel lines are secured using <b>fasteners</b> to prevent chafing or kinking of lines
H-36.01.09P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>

H-36.01.10P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
H-36.01.11P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: refrigerant leak detectors, electrical contact cleaners, terminal brushes  
**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: batteries, wires, starters, alternators, compressors, fuel tanks

**preventative maintenance checks** includes: battery load test, checking for water in tank, checking codes, inspecting belts, checking fluid and fuel levels, checking seals

**fasteners** include: insulated clamps, separators

**consumables** include: oil, fuel, coolant, filters

Knowledge		
	Learning Outcomes	Learning Objectives
H-36.01.01L	demonstrate knowledge of heating systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of heating systems and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of heating systems and their <b>components</b>
		identify <b>fuel systems</b> , and describe their characteristics and applications
		identify <b>power supplies</b> , and describe their characteristics and applications
		identify <b>high-voltage systems</b> , and describe their characteristics and applications
		identify mounting structures, <b>fasteners</b> and reinforcements, and describe their characteristics and applications
H-36.01.02L	demonstrate knowledge of refrigeration systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify <b>fluid</b> levels, and describe their characteristics and applications
		identify types of refrigeration systems and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of refrigeration systems and their <b>components</b>

H-36.01.03L	demonstrate knowledge of procedures to service heating and refrigeration systems and their <b>components</b> and <b>consumables</b>	identify <b>tools and equipment</b> used to service heating and refrigeration systems and their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to heating and refrigeration systems, and their <b>components</b> and <b>consumables</b>
		describe procedures to inspect heating and refrigeration systems, and their <b>components</b> and <b>consumables</b>
		describe procedures to clean, lubricate and adjust heating and refrigeration system <b>components</b>
		describe procedures to remove, replace, recycle and dispose of heating and refrigeration system <b>consumables</b>
		identify materials that can be reconditioned, reused or recycled
H-36.01.04L	demonstrate knowledge of training and certification requirements pertaining to heating and refrigeration systems	identify training and certification requirements pertaining to heating and refrigeration systems
H-36.01.05L	demonstrate knowledge of regulatory requirements pertaining to heating and refrigeration systems	identify and interpret standards and regulations pertaining to heating and refrigeration systems
H-36.01.06L	demonstrate knowledge of regulatory requirements pertaining to recycling and disposal of heating and refrigeration system <b>consumables</b>	identify and interpret standards and regulations pertaining to recycling and disposal of heating and refrigeration system <b>consumables</b>
H-36.01.07L	demonstrate knowledge of emerging technologies and practices pertaining to heating and refrigeration systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**components** include: batteries, wires, starters, alternators, compressors, fuel tanks

**consumables** include: oil, fuel, coolant, filters

**fuel systems** include: diesel, propane, natural gas

**power supplies** include: electric, diesel, propane, natural gas

**high-voltage systems** include: genset, hybrid

**fasteners** include: insulated clamps, separators

**fluids** include: antifreeze, motor oil, fuel

**tools and equipment** include: refrigerant leak detectors, electrical contact cleaners, terminal brushes

**hazards** include: high-pressure injection, carcinogenic and toxic refrigerant gases, burns, skin irritations, shocks

## H-36.02 Diagnoses heating and refrigeration systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
H-36.02.01P	identify <b><i>symptoms of problems</i></b>	<b><i>symptoms of problems</i></b> are identified by consulting with customer or operator
H-36.02.02P	select and use <b><i>tools and equipment</i></b>	<b><i>tools and equipment</i></b> are selected and used according to task and <b><i>manufacturers' service information</i></b>
H-36.02.03P	perform sensory inspections of starting and charging system	sensory inspections of starting and charging system are performed to identify worn, damaged and defective components
H-36.02.04P	determine <b><i>faults</i></b>	<b><i>faults</i></b> are determined
H-36.02.05P	load test battery	battery is load tested for CCA and operating condition (state of charge)
H-36.02.06P	test starting and charging systems	starting and charging systems are tested for voltage and amperage draw according to <b><i>manufacturers' service information</i></b>
H-36.02.07P	perform sensory inspections of fuel lines	sensory inspections of fuel lines are performed to identify <b><i>problems</i></b>
H-36.02.08P	check operation of <b><i>fuel delivery system components</i></b> on heating units	<b><i>fuel delivery system components</i></b> on heating units are checked for operation
H-36.02.09P	perform sensory inspections of fuel tank	sensory inspections of fuel tank are performed to identify <b><i>conditions</i></b>
H-36.02.10P	perform sensory inspections of fuel system mounting hardware	sensory inspections of fuel system mounting hardware are performed to identify <b><i>wear and damage</i></b>
H-36.02.11P	compare test results to <b><i>manufacturers' service information</i></b> or expected values	test results are compared to <b><i>manufacturers' service information</i></b> or expected values to verify diagnosis
H-36.02.12P	perform failure analysis	failure analysis is performed to determine root cause of failure
H-36.02.13P	record test results and inspection findings	test results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
H-36.02.14P	interpret diagnostic results	diagnostic results are interpreted to determine <b><i>next steps</i></b>

## Range of Variables

**symptoms of problems** include: no heat, no cooling, noises, smells, leaks

**tools and equipment** include: multimeters, ammeters, load testers, chargers, leak detectors

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**faults** include: corroded electric connectors, broken or loose belts, frayed or chafed wires

**problems** include: loose fittings, chafed or kinked lines, leaks

**fuel delivery system components** include: fuel pumps, gas regulators, filters

**conditions** includes: tank expiry date, physical damage

**wear and damage** includes: loose, worn or missing tank straps; cracked mounting brackets; broken fasteners

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
H-36.02.01L	demonstrate knowledge of heating systems, their components, characteristics, applications and operation	identify types of heating systems and their components, and describe their characteristics and applications
		describe operating principles of heating systems and their components
		identify <b>fuel systems</b> , and describe their characteristics and applications
		identify <b>power supplies</b> , and describe their characteristics and applications
		identify <b>high-voltage systems</b> , and describe their characteristics and applications
		identify mounting structures, <b>fasteners</b> and reinforcements, and describe their characteristics and applications
H-36.02.02L	demonstrate knowledge of refrigeration systems, their components, characteristics, applications and operation	identify <b>fluid</b> levels, and describe their characteristics and applications
		identify types of refrigeration systems and their components, and describe their characteristics and applications
H-36.02.03L	demonstrate knowledge of procedures to diagnose heating and refrigeration systems, and their <b>components</b>	describe operating principles of refrigeration systems and their components
		identify <b>tools and equipment</b> used to diagnose heating and refrigeration systems, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to heating and refrigeration systems, and their <b>components</b>

		interpret information pertaining to heating and refrigeration systems, and their <b>components</b> found in <b>manufacturers' service information</b>
		describe procedures to inspect heating and refrigeration systems, and their <b>components</b>
		describe procedures to test heating and refrigeration systems, and their <b>components</b>
		describe procedures to diagnose heating and refrigeration systems, and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify steps for failure analysis
		identify materials that can be reconditioned, reused or recycled
H-36.02.04L	demonstrate knowledge of training and certification requirements pertaining to heating and refrigeration systems	identify training and certification requirements pertaining to heating and refrigeration systems
H-36.02.05L	demonstrate knowledge of regulatory requirements pertaining to heating and refrigeration systems	identify and interpret standards and regulations pertaining to heating and refrigeration systems
H-36.02.06L	demonstrate knowledge of emerging technologies and practices pertaining to heating and refrigeration systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**fuel systems** include: diesel, propane, natural gas

**power supplies** include: electric, diesel, propane, natural gas

**high-voltage systems** include: genset, hybrid

**fasteners** include: insulated clamps, separators

**fluids** include: antifreeze, motor oil, fuel

**components** include: fuel tank, burner, blower motor, heater core, batteries, radiator, wires, alternators, engines, compressors, electronic sensing equipment, condensers, evaporators, belts, hoses

**tools and equipment** include: multimeters, ammeters, load testers, chargers, leak detectors

**hazards** include: high-pressure injection injury, carcinogenic and toxic refrigerant gases, burns, skin irritations, shocks

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**symptoms of problems** include: no heat, no cooling, noises, smells, leaks

## H-36.03 Repairs heating and refrigeration systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
H-36.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
H-36.03.02P	replace defective <b>components</b>	defective <b>components</b> are replaced according to <b>manufacturers' service information</b>
H-36.03.03P	remove and reinstall fuel tanks and brackets	fuel tanks and brackets are removed and reinstalled according to <b>manufacturers' service information</b>
H-36.03.04P	prime fuel system after repair or replacement of <b>components</b>	fuel system is primed after repair or replacement of <b>components</b>
H-36.03.05P	operate and adjust heating and refrigeration unit temperature controls	heating and refrigeration unit temperature controls are operated and adjusted according to load requirements and <b>manufacturers' service information</b>
H-36.03.06P	adjust belt tension	belt tension is adjusted using belt tension gauge according to <b>manufacturers' service information</b>
H-36.03.07P	verify repairs	repairs are verified using <b>methods</b>
H-36.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: multimeters, ammeters, load testers, chargers, manifold gauges, leak detectors

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: fuel lines, starters, alternators, pulleys, idler pulleys, belts, batteries

**methods** include: load testing, performing sensory observations, using gauges

### Knowledge

	Learning Outcomes	Learning Objectives
H-36.03.01L	demonstrate knowledge of heating systems, their <b>components</b> , characteristics, applications and operation	identify types of heating systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of heating systems and their <b>components</b>

		identify <b><i>fuel systems</i></b> , and describe their characteristics and applications
		identify <b><i>power supplies</i></b> , and describe their characteristics and applications
		identify <b><i>high-voltage systems</i></b> , and describe their characteristics and applications
		identify mounting structures, <b><i>fasteners</i></b> and reinforcements, and describe their characteristics and applications
		identify <b><i>fluid</i></b> levels, and describe their characteristics and applications
H-36.03.02L	demonstrate knowledge of refrigeration systems, their <b><i>components</i></b> , characteristics, applications and operation	identify types of refrigeration systems and their <b><i>components</i></b> , and describe their characteristics and applications
		describe operating principles of refrigeration systems and their <b><i>components</i></b>
H-36.03.03L	demonstrate knowledge of procedures to repair heating and refrigeration systems and their <b><i>components</i></b>	identify <b><i>tools and equipment</i></b> used to repair heating and refrigeration systems and their <b><i>components</i></b> , and describe their applications and procedures for use
		identify <b><i>hazards</i></b> and describe safe work practices pertaining to heating and refrigeration systems and their <b><i>components</i></b>
		interpret information pertaining to heating and refrigeration systems and their components found in <b><i>manufacturers' service information</i></b>
		describe procedures to remove, replace, adjust and repair heating and refrigeration systems and their <b><i>components</i></b>
		identify materials that can be reconditioned, reused or recycled
H-36.03.04L	demonstrate knowledge of training and certification requirements pertaining to heating and refrigeration systems	identify training and certification requirements pertaining to heating and refrigeration systems
H-36.03.05L	demonstrate knowledge of regulatory requirements pertaining to heating and refrigeration systems	identify and interpret standards and regulations pertaining to heating and refrigeration systems
H-36.03.06L	demonstrate knowledge of emerging technologies and practices pertaining to heating and refrigeration systems	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications



## Range of Variables

**components** include: fuel lines, starters, alternators, pulleys, idler pulleys, belts, batteries

**fuel systems** include: diesel, propane, natural gas

**power supplies** include: electric, diesel, propane, natural gas

**high-voltage systems** include: genset, hybrid

**fasteners** include: insulated clamps, separators

**fluids** include: antifreeze, motor oil, fuel

**tools and equipment** include: multimeters, ammeters, load testers, chargers, manifold gauges, leak detectors

**hazards** include: high-pressure injection injury, carcinogenic and toxic refrigerant gases, burns, skin irritations, shocks

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

# Major Work Activity I

## Services, diagnoses and repairs climate control systems

### Task I-37 Services, diagnoses and repairs heating and ventilation systems

#### Task Descriptor

Truck and transport mechanics service, diagnose and repair heating and ventilation systems for the comfort of the vehicle occupants.

#### I-37.01 Services heating and ventilation systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
I-37.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
I-37.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
I-37.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged and defective <b>components</b>
I-37.01.04P	measure air temperature and flow	air temperature and flow are measured to determine if they meet <b>manufacturers' service information</b>
I-37.01.05P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>

I-37.01.06P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
I-37.01.07P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be cleaned) include: filters, heater cores, ducting

**sensory inspections** include: visual check of levels, listening for motor noise and solenoid engagement, feeling air flow and temperature, smelling coolant leaks

**components** include: fins, heater controls, flow valves, blowers, pumps, resistors, modules, heater cores, ducting

**consumables** include: coolant, filters

Knowledge		
	Learning Outcomes	Learning Objectives
I-37.01.01L	demonstrate knowledge of heating and ventilation systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of heating and ventilation systems, their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of heating and ventilation systems, and their <b>components</b>
		interpret information pertaining to heating and ventilation systems, and their <b>components</b> found in <b>manufacturers' service information</b>
I-37.01.02L	demonstrate knowledge of procedures to service heating and ventilation systems, and their <b>components</b> and <b>consumables</b>	identify tools and equipment used to service heating and ventilation systems, and their <b>components</b> and <b>consumables</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to heating and ventilation systems, and their <b>components</b>
		describe procedures to inspect heating and ventilation systems, and their <b>components</b> and <b>consumables</b>
		describe procedures to clean heating and ventilation system <b>components</b>
		describe procedures to measure air flow and temperature

		describe procedures to remove, replace, recycle and dispose of heating and ventilation system <b>consumables</b>
I-37.01.03L	demonstrate knowledge of <b>emerging technologies</b> and practices pertaining to heating and ventilation systems	identify <b>emerging technologies</b> pertaining to heating and ventilation systems

## Range of Variables

**components** include: fins, heater controls, flow valves, blowers, pumps, resistors, modules, heater cores, ducting

**consumables** include: coolant, filters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: hot surfaces, sharp edges, hot coolants

**emerging technologies** include: alternative auxiliary heaters

## I-37.02 Diagnoses heating and ventilation systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
I-37.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
I-37.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
I-37.02.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
I-37.02.04P	perform diagnostic procedures and <b>tests</b>	diagnostic procedure and <b>tests</b> are performed by following <b>manufacturers' service information</b> to determine failure
I-37.02.05P	perform failure analysis	failure analysis is performed to determine root cause of failure
I-37.02.06P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
I-37.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: malfunctioning heat controls, steaming windshield, coolant smell, no heat

**tools and equipment** include: breakout harnesses, multimeters, thermometers, air flow gauges, vacuum cleaners, electronic service tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: visual check of levels, listening for motor noise and solenoid engagement, feeling air flow and temperature, smelling coolant leaks

**tests** include: operational, air flow, temperature

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
I-37.02.01L	demonstrate knowledge of heating and ventilation systems, their <b>components</b> , characteristics, applications and operation	identify types of heating and ventilation systems, and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of heating and ventilation systems, and their <b>components</b>
		interpret information pertaining to heating and ventilation systems, and their <b>components</b> found in <b>manufacturers' service information</b>
I-37.02.02L	demonstrate knowledge of procedures to diagnose heating and ventilation systems, and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose heating and ventilation systems, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to heating and ventilation systems, and their <b>components</b>
		describe procedures to inspect heating and ventilation systems, and their <b>components</b>
		describe procedures to diagnose and test heating and ventilation systems, and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
I-37.02.03L	demonstrate knowledge of <b>emerging technologies</b> and practices pertaining to heating and ventilation systems	identify <b>emerging technologies</b> pertaining to heating and ventilation systems

## Range of Variables

**components** include: fins, heater controls, flow valves, blowers, pumps, resistors, modules, heater cores, ducting

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**tools and equipment** include: breakout harnesses, multimeters, thermometers, air flow gauges, vacuum cleaners, electronic service tools

**hazards** include: hot surfaces, sharp edges, hot coolants

**symptoms of problems** include: malfunctioning heat controls, steaming windshield, coolant smell, no heat

**emerging technologies** include: alternative auxiliary heaters

### I-37.03 Repairs heating and ventilation systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
I-37.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
I-37.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
I-37.03.03P	repair <b>components</b>	<b>components</b> are repaired by changing worn, damaged and defective parts according to <b>manufacturers' service information</b>
I-37.03.04P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
I-37.03.05P	verify repairs	repairs are verified using <b>methods</b>
I-37.03.06P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be replaced) include: thermostats, blowers, flow valves, heater cores, radiators, heater boxes, actuators, filters

**components** (to be repaired) include: flow valves, solenoids, auxiliary heaters

**components** (to be cleaned) include: blowers, heater cores, radiators, heater boxes, filters

**methods** include: road testing, sensory observations, air flow and temperature testing

Knowledge		
	Learning Outcomes	Learning Objectives
I-37.03.01L	demonstrate knowledge of heating and ventilation systems, their <b>components</b> , characteristics, applications and operation	identify types of heating and ventilation systems, and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of heating and ventilation systems, and their <b>components</b>
		interpret information pertaining to heating and ventilation systems, and their <b>components</b> found in <b>manufacturers' service information</b>
I-37.03.02L	demonstrate knowledge of procedures to repair heating and ventilation systems, and their <b>components</b>	identify tools and equipment used to repair heating and ventilation systems, and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to heating and ventilation systems, and their <b>components</b>
		describe procedures to remove, replace, clean and repair heating and ventilation systems, and their <b>components</b>
I-37.03.03L	demonstrate knowledge of practices and <b>emerging technologies</b> pertaining to heating and ventilation systems	identify <b>emerging technologies</b> pertaining to heating and ventilation systems

## Range of Variables

**components** include: thermostats, blowers, flow valves, heater cores, radiators, heater boxes, actuators, filters, solenoids, auxiliary heaters

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hazards** include: hot surfaces, sharp edges, hot coolants

**emerging technologies** include: alternative auxiliary heaters

# Task I-38 Services, diagnoses and repairs air conditioning systems

## Task Descriptor

Truck and transport mechanics service, diagnose and repair air conditioning systems for the comfort of the vehicle occupants.

### I-38.01 Services air conditioning systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
I-38.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
I-38.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
I-38.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged and defective <b>components</b>
I-38.01.04P	measure air temperature and flow	air temperature and flow are measured to determine if they meet <b>manufacturers' service information</b>
I-38.01.05P	remove, replace, recycle and dispose of filters	filters are removed, replaced, recycled and disposed of according to <b>manufacturers' service information</b>
I-38.01.06P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

### Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be cleaned) include: condensers, evaporator cores, filters, blower motors

**sensory inspections** include: performing visual check of levels, feeling air flow and temperature, listening for motor noise, checking for frost, listening for compressor engagement, looking for signs of leakage

**components** include: evaporators, condensers, compressors, receiver dryers, expansion valves, orifice tubes, accumulators, sensors, controls, lines, filters, blower motors



Knowledge		
	Learning Outcomes	Learning Objectives
I-38.01.01L	demonstrate knowledge of air conditioning systems, their <b>components</b> , characteristics, applications and operation	identify air conditioning systems and their <b>components</b> , and describe their characteristics and applications describe operating principles of air conditioning systems and their <b>components</b> identify <b>types of refrigerants</b> and describe their characteristics and applications
I-38.01.02L	demonstrate knowledge of procedures to service air conditioning systems and their <b>components</b>	identify tools and equipment used to service air conditioning systems and their <b>components</b> , and describe their applications and procedures for use identify <b>hazards</b> and describe safe work practices pertaining to air conditioning systems and their <b>components</b> describe procedures to inspect air conditioning systems and their <b>components</b> describe procedures to clean air conditioning systems and their <b>components</b>
I-38.01.03L	demonstrate knowledge of <b>training and certification requirements</b> pertaining to air conditioning systems	identify <b>training and certification requirements</b> pertaining to air conditioning systems
I-38.01.04L	demonstrate knowledge of regulatory requirements pertaining to air conditioning systems	identify and interpret <b>standards and regulations</b> pertaining to air conditioning systems
I-38.01.05L	demonstrate knowledge of <b>emerging technologies</b> and practices pertaining to air conditioning systems	identify technologies that address ozone depletion and pollution, and describe their characteristics and applications identify <b>emerging technologies</b> pertaining to air conditioning systems

## Range of Variables

**components** include: evaporators, condensers, compressors, receiver dryers, expansion valves, orifice tubes, accumulators, sensors, controls, lines, filters, blower motors

**types of refrigerants** include: R-12, R-134a, R-1234yf

**hazards** include: high pressure, flammable, sharp edges, pinch/crush points, moving parts, corrosive materials, irritants

**training and certification requirements** include: refrigerant handling training and certification

**standards and regulations** include: reclaiming, recycling and disposal regulations

**emerging technologies** include: auxiliary air conditioning units, refrigerant technology

## I-38.02 Diagnoses air conditioning systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
I-38.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
I-38.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
I-38.02.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged and defective <b>components</b>
I-38.02.04P	confirm complaint and establish preliminary diagnosis	complaint is confirmed and preliminary diagnosis is established
I-38.02.05P	perform diagnostic procedures and <b>tests</b>	diagnostic procedures and <b>tests</b> are performed by following <b>manufacturers' service information</b> to determine failure
I-38.02.06P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
I-38.02.07P	perform failure analysis	failure analysis is performed to determine root cause of failure
I-38.02.08P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
I-38.02.09P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

### Range of Variables

**symptoms of problems** include: poor cooling, noises, windows fogging

**tools and equipment** include: air conditioning recovery machines, pressure gauges, nitrogen, multimeters, electronic service tools, temperature and flow gauges, leak detectors

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: performing visual check of levels, feeling air flow and temperature, listening for motor noise, checking for frost, listening for compressor engagement, looking for signs of leakage

**components** include: evaporators, condensers, compressors, receiver dryers, expansion valves, orifice tubes, accumulators, sensors, controls, lines, filters, blower motors

**tests** include: pressure, electrical, leakage, vacuum

**next steps** include: repairs, component replacement or adjustment, further diagnosis

## Knowledge

Learning Outcomes		Learning Objectives
I-38.02.01L	demonstrate knowledge of air conditioning systems, their <b>components</b> , characteristics, applications and operation	identify air conditioning systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of air conditioning systems and their <b>components</b>
		interpret information pertaining to air conditioning systems found in <b>manufacturers' service information</b>
		identify <b>types of refrigerants</b> and describe their characteristics and applications
I-38.02.02L	demonstrate knowledge of procedures to diagnose air conditioning systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose air conditioning systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to air conditioning systems and their <b>components</b>
		describe procedures to inspect air conditioning systems and their <b>components</b>
		describe procedures to test air conditioning systems and their <b>components</b>
		describe procedures to diagnose air conditioning systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
I-38.02.03L	demonstrate knowledge of <b>training and certification requirements</b> pertaining to air conditioning systems	identify <b>training and certification requirements</b> pertaining to air conditioning systems
I-38.02.04L	demonstrate knowledge of regulatory requirements pertaining to air conditioning systems	identify and interpret <b>standards and regulations</b> pertaining to air conditioning systems
I-38.02.05L	demonstrate knowledge of <b>emerging technologies</b> and practices pertaining to air conditioning systems	identify technologies that address ozone depletion and pollution, and describe their characteristics and applications
		identify <b>emerging technologies</b> pertaining to air conditioning systems

## Range of Variables

**components** include: evaporators, condensers, compressors, receiver dryers, expansion valves, orifice tubes, accumulators, sensors, controls, lines, filters, blower motors

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**types of refrigerants** include: R-12, R-134a, R-1234yf

**tools and equipment** include: air conditioning recovery machines, pressure gauges, nitrogen, multimeters, electronic service tools, temperature and flow gauges, leak detectors

**hazards** include: high pressure, flammable, sharp edges, pinch/crush points, moving parts, corrosive materials, irritants

**symptoms of problems** include: poor cooling, noises, windows fogging

**training and certification requirements** include: refrigerant handling training and certification

**standards and regulations** include: reclaiming, recycling and disposal regulations

**emerging technologies** include: auxiliary air conditioning units, refrigerant technology

### I-38.03 Repairs air conditioning systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
I-38.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
I-38.03.02P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced
I-38.03.03P	adjust refrigerant pressures	refrigerant pressures are adjusted to ensure proper operation of <b>components</b> and equipment
I-38.03.04P	brazing or soldering lines	lines are brazed or soldered using welding equipment
I-38.03.05P	evacuate, clean and recharge system refrigerant	system refrigerant is evacuated, cleaned and recharged according to <b>manufacturers' service information</b>
I-38.03.06P	recycle refrigerant	refrigerant is recycled according to jurisdictional regulations
I-38.03.07P	verify repair	repair is verified by running air conditioning system
I-38.03.08P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: air conditioning recovery system, pressure and temperature gauges, vacuum pumps, refrigerant identifiers, welding equipment

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: evaporators, condensers, compressors, receiver dryers, expansion valves, orifice tubes, accumulators, sensors, controls, lines, filters, blower motors

Knowledge		
	Learning Outcomes	Learning Objectives
I-38.03.01L	demonstrate knowledge of air conditioning systems, their <b>components</b> , characteristics, applications and operation	identify air conditioning systems and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of air conditioning systems and their <b>components</b>
		identify <b>types of refrigerants</b> and describe their characteristics and applications
I-38.03.02L	demonstrate knowledge of procedures to repair air conditioning systems and their <b>components</b>	identify <b>tools and equipment</b> used to repair air conditioning systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to air conditioning systems and their <b>components</b>
		describe procedures to remove, replace, adjust and repair air conditioning systems and their <b>components</b>
I-38.03.03L	demonstrate knowledge of <b>training and certification requirements</b> pertaining to air conditioning systems	identify <b>training and certification requirements</b> pertaining to air conditioning systems
I-38.03.04L	demonstrate knowledge of regulatory requirements pertaining to air conditioning systems	identify and interpret <b>standards and regulations</b> pertaining to air conditioning systems
I-38.03.05L	demonstrate knowledge of <b>emerging technologies</b> and practices pertaining to air conditioning systems	identify technologies that address ozone depletion and pollution, and describe their characteristics and applications
		identify <b>emerging technologies</b> pertaining to air conditioning systems

## Range of Variables

**components** include: evaporators, condensers, compressors, receiver dryers, expansion valves, orifice tubes, accumulators, sensors, controls, lines, filters, blower motors

**types of refrigerants** include: R-12, R-134a, R-1234yf

**tools and equipment** include: air conditioning recovery system, pressure and temperature gauges, vacuum pumps, refrigerant identifiers, welding equipment

**hazards** include: high pressure, flammable, sharp edges, pinch/crush points, moving parts, corrosive materials, irritants

**training and certification requirements** include: refrigerant handling training and certification

**standards and regulations** include: reclaiming, recycling and disposal regulations

**emerging technologies** include: auxiliary air conditioning units, refrigerant technology

# Major Work Activity J

## Services, diagnoses and repairs hydraulic systems

### Task J-39 Services, diagnoses and repairs hydraulic systems

#### Task Descriptor

Hydraulic systems pump confined fluid to transfer energy smoothly from one component to another. Advantages of using hydraulics include smooth and quiet operation, and adjustability of speed and force to prevent damage, which allows for a versatile and adaptable system.

Truck and transport mechanics must service, diagnose and repair hydraulic systems to ensure proper function and reduce down time.

#### J-39.01 Services hydraulic systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
J-39.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
J-39.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
J-39.01.03P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to identify worn, damaged and defective <b>components</b>
J-39.01.04P	release stored energy	stored energy is released in a controlled manner without releasing fluid from system
J-39.01.05P	support raised components mechanically	raised components are supported mechanically to prevent accidental dropping of component or load
J-39.01.06P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>

J-39.01.07P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
J-39.01.08P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** (to be cleaned) include: inlet screens, reservoirs

**sensory inspections** include: listening for noises, looking for leaks, feeling for hot spots, smelling for burnt oil

**components** include: gaskets, seals, hoses, fittings, pumps, actuators, relief valves, control valves, reservoirs, PTO, drop boxes (transfer case), ECMs, solenoids, sensors, harnesses

**consumables** include: filters, oil

Knowledge		
	Learning Outcomes	Learning Objectives
J-39.01.01L	demonstrate knowledge of hydraulic systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify hydraulic systems and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of hydraulic systems and their <b>components</b>
		identify pressure limits of hoses, tubing and fittings
		identify types of <b>hydraulically powered applications</b>
J-39.01.02L	demonstrate knowledge of procedures to service hydraulic systems and <b>components</b>	identify tools and equipment used to service hydraulic systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to hydraulic systems and their <b>components</b>
		describe procedures to release stored energy
		describe procedures to inspect hydraulic systems and their <b>components</b>
		describe procedures to clean hydraulic systems and their <b>components</b>
		describe procedures to remove, replace, recycle and dispose of hydraulic <b>consumables</b>
		identify oil sampling procedures



J-39.01.03L	demonstrate knowledge of training and certification requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>	identify training and certification requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>
J-39.01.04L	demonstrate knowledge of regulatory requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>	identify codes, standards and regulations pertaining to hydraulic systems and <b>hydraulically powered applications</b>

## Range of Variables

**components** include: gaskets, seals, hoses, fittings, pumps, actuators, relief valves, control valves, reservoirs, PTO, drop boxes (transfer case), ECMs, solenoids, sensors, harnesses

**consumables** include: filters, oil

**hydraulically powered applications** include: cement mixers, dump boxes, compactors, snow removal equipment, lift gates, aerial lifts, mobile cranes

**hazards** include: stored high pressure, skin and eye irritation, flammability, high heat

## J-39.02 Diagnoses hydraulic systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

Performance Criteria		Evidence of Attainment
J-39.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
J-39.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
J-39.02.03P	release stored energy	stored energy is released in a controlled manner without releasing fluid from system
J-39.02.04P	support raised components mechanically	raised components are supported mechanically to prevent accidental dropping of component or load
J-39.02.05P	perform <b>sensory inspections</b>	<b>sensory inspections</b> are performed to confirm complaint and establish preliminary diagnosis
J-39.02.06P	perform diagnostic procedure	diagnostic procedure is performed by following <b>manufacturers' service information</b> to determine failure
J-39.02.07P	perform <b>tests</b>	<b>tests</b> are performed to assess <b>components</b> for wear, damage or defects

J-39.02.08P	compare <b>test</b> results to <b>manufacturers' service information</b> or expected values to verify diagnosis	<b>test</b> results are compared to <b>manufacturers' service information</b> or expected values to verify diagnosis
J-39.02.09P	perform failure analysis	failure analysis is performed to determine root cause of failure
J-39.02.10P	record <b>test</b> results and inspection findings	<b>test</b> results and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking
J-39.02.11P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: fail to raise or lower, slow operation, leaking, intermittent or erratic operation, noisy operation

**tools and equipment** include: pressure gauges, flow meters, temperature gauges, restriction gauges  
**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**sensory inspections** include: listening for noises, looking for leaks, feeling for hot spots, smelling for burnt oil

**tests** include: pressure, flow, restriction, cycle time

**components** include: gaskets, seals, hoses, fittings, pumps, actuators, relief valves, control valves, reservoir, PTO, drop boxes (transfer case), ECMs, solenoids, sensors, harnesses

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
J-39.02.01L	demonstrate knowledge of hydraulic systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify hydraulic systems and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of hydraulic systems and their <b>components</b>
		identify pressure limits of hoses, tubing and fittings
		identify types of <b>hydraulically powered applications</b>
J-39.02.02L	demonstrate knowledge of procedures to diagnose hydraulic systems and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose hydraulic systems and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to hydraulic systems and their <b>components</b>
		describe procedures to release stored energy

		describe procedures to inspect hydraulic systems and their <b>components</b>
		describe procedures to test hydraulic systems and their <b>components</b>
		describe procedures to diagnose hydraulic systems and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify oil sampling procedures
J-39.02.03L	demonstrate knowledge of training and certification requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>	identify training and certification requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>
J-39.02.04L	demonstrate knowledge of regulatory requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>	identify codes, standards and regulations pertaining to hydraulic systems and <b>hydraulically powered applications</b>

## Range of Variables

**components** include: gaskets, seals, hoses, fittings, pumps, actuators, relief valves, control valves, reservoir, PTO, drop boxes (transfer case), ECMs, solenoids, sensors, harnesses

**consumables** include: filters, oil

**hydraulically powered applications** include: cement mixers, dump boxes, compactors, snow removal equipment, lift gates, aerial lifts, mobile cranes

**tools and equipment** include: pressure gauges, flow meters, temperature gauges, restriction gauges

**hazards** include: stored high pressure, skin and eye irritation, flammability, high heat

**symptoms of problems** include: fail to raise or lower, slow operation, leaking, intermittent or erratic operation, noisy operation

## J-39.03 Repairs hydraulic systems

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	yes	yes	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
J-39.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task and <b>manufacturers' service information</b>
J-39.03.02P	release stored energy	stored energy is released in a controlled manner without releasing fluid from system
J-39.03.03P	support raised components mechanically	raised components are supported mechanically to prevent accidental dropping of component or load

J-39.03.04P	remove and replace worn, damaged and faulty <b>components</b>	worn, damaged and faulty <b>components</b> are removed and replaced according to <b>manufacturers' service information</b>
J-39.03.05P	rebuild <b>components</b>	<b>components</b> are rebuilt according to <b>manufacturers' service information</b>
J-39.03.06P	repair <b>components</b>	<b>components</b> are repaired by replacing parts causing failure according to <b>manufacturers' service information</b>
J-39.03.07P	perform <b>adjustments</b>	<b>adjustments</b> are performed to ensure proper operation of <b>components</b> and equipment
J-39.03.08P	verify repairs	repairs are verified using <b>methods</b> according to <b>manufacturers' service information</b>
J-39.03.09P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**components** include: gaskets, seals, hoses, fittings, oil, pumps, actuators, relief valves, control valves, reservoirs, PTO, drop boxes (transfer case), ECMs, solenoids, sensors, harnesses

**adjustments** include: setting pressure and flow

**methods** include: operational tests, verifying pressures and flow

Knowledge		
	Learning Outcomes	Learning Objectives
J-39.03.01L	demonstrate knowledge of hydraulic systems, their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify hydraulic systems and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of hydraulic systems and their <b>components</b>
		interpret information pertaining to hydraulic systems and their <b>components</b> found in <b>manufacturers' service information</b>
		identify pressure limits of hoses, tubing and fittings
		identify types of <b>hydraulically powered applications</b>
J-39.03.02L	demonstrate knowledge of procedures to repair hydraulic systems and their <b>components</b>	identify tools and equipment used to repair hydraulic systems and their <b>components</b> , and describe their applications and procedures for use

		identify <b>hazards</b> and describe safe work practices pertaining to hydraulic systems and their <b>components</b>
		describe procedures to release stored energy
		describe procedures to remove, replace, adjust and repair hydraulic systems and their <b>components</b>
J-39.03.03L	demonstrate knowledge of training and certification requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>	identify training and certification requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>
J-39.03.04L	demonstrate knowledge of regulatory requirements pertaining to hydraulic systems and <b>hydraulically powered applications</b>	identify codes, standards and regulations pertaining to hydraulic systems and <b>hydraulically powered applications</b>

## Range of Variables

**components** include: gaskets, seals, hoses, fittings, oil, pumps, actuators, relief valves, control valves, reservoirs, PTO, drop boxes (transfer case), ECMs, solenoids, sensors, harnesses

**consumables** include: filters, oil

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards

**hydraulically powered applications** include: cement mixers, dump boxes, compactors, snow removal equipment, lift gates, aerial lifts, mobile cranes

**hazards** include: stored high pressure, skin and eye irritation, flammability, high heat

# Major Work Activity K

## Services, diagnoses and repairs hybrid and electric vehicles (EV)

### Task K-40 Services, diagnoses and repairs hybrid vehicles

#### Task Descriptor

Truck and transport mechanics service, diagnose and repair electric motors, inverters, converters, high-voltage batteries and associated support systems in hybrid vehicles.

#### K-40.01 Services hybrid vehicles

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	no	no	yes	NV	NV	NV

#### Skills

	Performance Criteria	Evidence of Attainment
K-40.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to <b>manufacturers' service information</b>
K-40.01.02P	deactivate and lock out high- and low-voltage electrical system, and engine operating system	high- and low-voltage electrical system, and engine operating system are deactivated and locked out according to vehicle training and <b>manufacturers' service information</b>
K-40.01.03P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify <b>defects</b>
K-40.01.04P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>
K-40.01.05P	read and clear fault codes, and update software	fault codes are read and cleared, and software is updated according to <b>manufacturers' service information</b>
K-40.01.6P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: specialized PPE, safety devices, specialized digital multimeters (DMM), electronic service tools, specialized hand tools (insulated tools)

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

**consumables** include: filters, fluids

Knowledge		
	Learning Outcomes	Learning Objectives
K-40.01.01L	demonstrate knowledge of <b>hybrid vehicle systems</b> , their <b>components</b> , characteristics, applications and operation	identify types of <b>hybrid vehicle systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of <b>hybrid vehicle systems</b> and their <b>components</b>
		interpret information pertaining to <b>hybrid vehicle systems</b> and their <b>components</b> found in <b>manufacturers' service information</b>
K-40.01.02L	demonstrate knowledge of procedures to service <b>hybrid vehicle systems</b> and their <b>components</b>	identify <b>tools and equipment</b> used to service <b>hybrid vehicle systems</b> and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>hybrid vehicle systems</b> and their <b>components</b>
		describe procedures to release or lock out stored energy
		describe procedures to disconnect and reconnect high-voltage systems in hybrid vehicles
		describe procedures to service <b>hybrid vehicle systems</b> and their <b>components</b>
		describe procedures to perform software updates and read and clear fault codes
		identify <b>defects</b> found in <b>hybrid vehicle systems</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
K-40.01.03L	demonstrate knowledge of training requirements to service <b>hybrid vehicle systems</b> and their <b>components</b>	identify training requirements to service <b>hybrid vehicle systems</b> and their <b>components</b>

K-40.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to <b>hybrid vehicle systems</b> and their <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**hybrid vehicle systems** include: series, parallel, series/parallel

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**tools and equipment** include: specialized PPE, safety devices, specialized digital multimeters (DMM), electronic service tools, specialized hand tools (insulated tools)

**hazards** include: shocks, arc flash, sparks, heavy weights, falls, high working temperatures

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

## K-40.02 Diagnoses hybrid vehicles

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	no	no	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
K-40.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
K-40.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
K-40.02.03P	deactivate and lock out high- and low-voltage electrical system, and engine operating system	high- and low-voltage electrical system, and engine operating system are deactivated and locked out according to <b>manufacturers' service information</b>
K-40.02.04P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify <b>defects</b>
K-40.02.05P	retrieve fault codes	fault codes are retrieved according to <b>manufacturers' service information</b>



K-40.02.06P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b> to pinpoint failure
K-40.02.07P	interpret diagnostic results	diagnostic results are interpreted according to <b>manufacturers' service information</b> to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: lack of power, no vehicle movement, no start, noises, indicator lights, components not functioning, intermittent operation

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

**tests** include: active, voltage and amperage, resistance check, voltage isolation, insulation, road

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
K-40.02.01L	demonstrate knowledge of <b>hybrid vehicle systems</b> , their <b>components</b> , characteristics, applications and operation	identify types of <b>hybrid vehicle systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of <b>hybrid vehicle systems</b> and their <b>components</b>
		interpret information pertaining to <b>hybrid vehicle systems</b> and their <b>components</b> found in <b>manufacturers' service information</b>
K-40.02.02L	demonstrate knowledge of procedures to diagnose <b>hybrid vehicle systems</b> and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose <b>hybrid vehicle systems</b> and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>hybrid vehicle systems</b> and their <b>components</b>
		describe procedures to release or lock out stored energy
		describe procedures to inspect <b>hybrid vehicle systems</b> and their <b>components</b>
		describe procedures to test <b>hybrid vehicle systems</b> and their <b>components</b>
		describe procedures to diagnose <b>hybrid vehicle systems</b> and their <b>components</b>

		describe procedures to perform software updates, and read and clear fault codes
		describe common causes and <b>symptoms of problems</b>
		identify <b>defects</b> founds while diagnosing <b>hybrid vehicle systems</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
K-40.02.03L	demonstrate knowledge of training requirements to service <b>hybrid vehicle systems</b> and their <b>components</b>	identify training requirements to service <b>hybrid vehicle systems</b> and their <b>components</b>
K-40.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to <b>hybrid vehicle systems</b> and their <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**hybrid vehicle systems** include: series, parallel, series/parallel

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers

**hazards** include: shocks, arc flash, sparks, falls

**symptoms of problems** include: lack of power, no vehicle movement, no start, noises, indicator lights, components not functioning, intermittent operation

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

## K-40.03 Repairs hybrid vehicles

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	no	no	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
K-40.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
K-40.03.02P	deactivate and lock out high- and low-voltage electrical system, and engine operating system	high- and low-voltage electrical system, and engine operating system are deactivated and locked out according to <b>manufacturers' service information</b>
K-40.03.03P	remove and inspect <b>components</b>	<b>components</b> are removed and inspected according to <b>manufacturers' service information</b>
K-40.03.04P	replace or repair <b>components</b>	<b>components</b> are replaced or repaired according to <b>manufacturers' service information</b>
K-40.03.05P	clear fault codes	fault codes are cleared according to <b>manufacturers' service information</b>
K-40.03.06P	verify repairs	repairs are verified under normal operating conditions to ensure they are within <b>manufacturers' service information</b>
K-40.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

### Range of Variables

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers, lift-assist tools, hand tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring

### Knowledge

	Learning Outcomes	Learning Objectives
K-40.03.01L	demonstrate knowledge of <b>hybrid vehicle systems</b> , their <b>components</b> , characteristics, applications and operation	identify types of <b>hybrid vehicle systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of <b>hybrid vehicle systems</b> and their <b>components</b>

		interpret information pertaining to <b>hybrid vehicle systems</b> and their <b>components</b> found in <b>manufacturers' service information</b>
K-40.03.02L	demonstrate knowledge of procedures to repair <b>hybrid vehicle systems</b> and their <b>components</b>	identify <b>tools and equipment</b> used to repair <b>hybrid vehicle systems</b> and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>hybrid vehicle systems</b> and their <b>components</b>
		describe procedures to release or lock out stored energy
		describe procedures to disconnect and reconnect high-voltage systems in hybrid vehicles
		describe procedures to replace and repair <b>hybrid vehicle system components</b>
		describe procedures to perform software updates, and read and clear fault codes
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
K-40.03.03L	demonstrate knowledge of training requirements to service <b>hybrid vehicle systems</b> and their <b>components</b>	identify training requirements to service <b>hybrid vehicle systems</b> and their <b>components</b>
K-40.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to <b>hybrid vehicle systems</b> and their <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**hybrid vehicle systems** include: series, parallel, series/parallel

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers, lift-assist tools, hand tools

**hazards** include: shocks, arc flash, sparks, heavy weights, falls, burns, high working temperatures

## Task K-41 Services, diagnoses and repairs electric vehicles (EV)

### Task Descriptor

Truck and transport mechanics work on electric motors, inverters, converters, high-voltage batteries and associated support systems in electric vehicles (EV).

#### K-41.01 Services electric vehicles (EV)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	no	no	yes	NV	NV	NV

#### Skills

Performance Criteria		Evidence of Attainment
K-41.01.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
K-41.01.02P	clean <b>components</b>	<b>components</b> are cleaned according to <b>manufacturers' service information</b>
K-41.01.03P	measure charging rails	charging rails are measured according to <b>manufacturers' service information</b>
K-41.01.04P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify <b>defects</b>
K-41.01.05P	deactivate and lock out high- and low-voltage electrical system, and charging devices	high- and low-voltage electrical system, and charging devices are deactivated and locked out according to vehicle training and <b>manufacturers' service information</b>
K-41.01.06P	remove and replace <b>consumables</b>	<b>consumables</b> are removed and replaced according to <b>manufacturers' service information</b>
K-41.01.07P	recycle and dispose of <b>consumables</b>	<b>consumables</b> are recycled and disposed of according to jurisdictional regulations
K-41.01.08P	replace <b>components</b>	<b>components</b> are replaced according to <b>manufacturers' service information</b>
K-41.01.09P	read and clear fault codes, and update software	fault codes are read and cleared, and software is updated according to <b>manufacturers' service information</b>
K-41.01.10P	record service information and inspection findings	service information and inspection findings are recorded according to manufacturers' requirements for warranty, and for future reference and tracking

## Range of Variables

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools)

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring, charging systems

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

**consumables** include: filters, fluids

Knowledge		
	Learning Outcomes	Learning Objectives
K-41.01.01L	demonstrate knowledge of <b>EV systems</b> , their <b>components</b> , <b>consumables</b> , characteristics, applications and operation	identify types of <b>EV systems</b> and their <b>components</b> and <b>consumables</b> , and describe their characteristics and applications
		describe operating principles of <b>EV systems</b> and their <b>components</b>
K-41.01.02L	demonstrate knowledge of procedures to service <b>EV systems</b> and their <b>components</b>	identify <b>tools and equipment</b> used to service <b>EV systems</b> and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>EV systems</b> and their <b>components</b>
		describe procedures to release or lock out stored energy
		describe procedures to service <b>EV systems</b> and their <b>components</b>
		describe procedures to inspect <b>EV systems</b> and their <b>components</b>
		describe procedures to clean <b>EV system components</b>
		describe procedures to measure charging rails
		describe procedures to remove, replace, recycle and dispose of <b>consumables</b>
		describe procedures to perform software updates, and read and clear fault codes
		identify <b>defects</b> found in <b>EV systems</b>
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste

K-41.01.03L	demonstrate knowledge of training requirements to service <b>EV systems</b> and their <b>components</b>	identify training requirements to service <b>EV systems</b> and their <b>components</b>
K-41.01.04L	demonstrate knowledge of emerging technologies and practices pertaining to <b>EV systems</b> and their <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**EV systems** include: A/C drives, fast charge, plug-in, extended range

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring, charging systems

**consumables** include: filters, fluids

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools)

**hazards** include: shocks, arc flash, sparks, heavy weights, falls, high working temperatures

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

## K-41.02 Diagnoses electric vehicles (EV)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	no	no	yes	NV	NV	NV

Skills		
	Performance Criteria	Evidence of Attainment
K-41.02.01P	identify <b>symptoms of problems</b>	<b>symptoms of problems</b> are identified by consulting with customer or operator
K-41.02.02P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
K-41.02.03P	deactivate and lock out high- and low-voltage electrical system and charging devices	high- and low-voltage electrical system and charging devices are deactivated and locked out according to <b>manufacturers' service information</b>
K-41.02.04P	perform sensory inspections	sensory inspections of <b>components</b> are performed to identify <b>defects</b>
K-41.02.05P	retrieve fault codes	fault codes are retrieved according to <b>manufacturers' service information</b>

K-41.02.06P	perform <b>tests</b>	<b>tests</b> are performed according to <b>manufacturers' service information</b> to pinpoint failure
K-41.02.07P	interpret diagnostic results	diagnostic results are interpreted to determine <b>next steps</b>

## Range of Variables

**symptoms of problems** include: lack of power, no vehicle movement, noises, indicator lights, components not functioning, intermittent operation

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring, charging systems

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

**tests** include: active, voltage and amperage, resistance check, voltage isolation, insulation, road

**next steps** include: repairs, component replacement or adjustment, further diagnosis

Knowledge		
	Learning Outcomes	Learning Objectives
K-41.02.01L	demonstrate knowledge of <b>EV systems</b> , their <b>components</b> , characteristics, applications and operation	identify types of <b>EV systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of <b>EV systems</b> and their <b>components</b>
K-41.02.02L	demonstrate knowledge of procedures to diagnose <b>EV systems</b> and their <b>components</b>	identify <b>tools and equipment</b> used to diagnose <b>EV systems</b> and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>EV systems</b> and their <b>components</b>
		describe procedures to inspect <b>EV systems</b> and their <b>components</b>
		describe procedures to test <b>EV systems</b> and their <b>components</b>
		describe procedures to diagnose <b>EV systems</b> and their <b>components</b>
		describe common causes and <b>symptoms of problems</b>
		identify <b>defects</b> found in <b>EV systems</b>
		identify materials that can be reconditioned, reused or recycled



		identify practices that reduce material waste
K-41.02.03L	demonstrate knowledge of training requirements to service <b>EV systems</b> and their <b>components</b>	identify training requirements to service <b>EV systems</b> and their <b>components</b>
K-41.02.04L	demonstrate knowledge of emerging technologies and practices pertaining to <b>EV systems</b> and their <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**EV systems** include: A/C drives, series, parallel, fast charge, plug-in, extended range

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring, charging systems

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers

**hazards** include: shocks, arc flash, sparks, falls, high working temperatures

**symptoms of problems** include: lack of power, no vehicle movement, noises, indicator lights, components not functioning, intermittent operation

**defects** include: loose components, damaged wiring, leaks, inoperable drive motors, damaged components

## K-41.03 Repairs electric vehicles (EV)

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	NV	yes	ND	yes	yes	no	no	yes	NV	NV	NV

### Skills

	Performance Criteria	Evidence of Attainment
K-41.03.01P	select and use <b>tools and equipment</b>	<b>tools and equipment</b> are selected and used according to task and <b>manufacturers' service information</b>
K-41.03.02P	deactivate and lock out high- and low-voltage electrical system, and engine operating system	high- and low-voltage electrical system, and engine operating system are deactivated and locked out according to <b>manufacturers' service information</b>
K-41.03.03P	remove and inspect <b>components</b>	<b>components</b> are removed and inspected according to <b>manufacturers' service information</b>
K-41.03.04P	replace or repair <b>components</b>	<b>components</b> are replaced or repaired according to <b>manufacturers' service information</b>

K-41.03.05P	clear fault codes	fault codes are cleared according to <b>manufacturers' service information</b>
K-41.03.06P	verify repairs	repairs are verified under normal operating conditions to ensure it is within <b>manufacturers' service information</b>
K-41.03.07P	document repairs and verifications performed	repairs and verifications performed are documented for warranty, liability, future reference and tracking

## Range of Variables

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers, lifting tools

**manufacturers' service information** include: maintenance schedule, specifications, recommendations, procedures, standards, service bulletins

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring, charging systems

Knowledge		
	Learning Outcomes	Learning Objectives
K-41.03.01L	demonstrate knowledge of <b>EV systems</b> , their <b>components</b> , characteristics, applications and operation	identify types of <b>EV systems</b> and their <b>components</b> , and describe their characteristics and applications
		describe operating principles of <b>EV systems</b> and their <b>components</b>
K-41.03.02L	demonstrate knowledge of procedures to repair <b>EV systems</b> and their <b>components</b>	identify <b>tools and equipment</b> used to repair <b>EV systems</b> and their <b>components</b> , and describe their applications and procedures for use
		identify <b>hazards</b> and describe safe work practices pertaining to <b>EV systems</b> and their <b>components</b>
		describe procedures to release or lock out stored energy
		describe procedures to repair and replace <b>EV system components</b>
		describe procedures to perform software updates, and read and clear fault codes
		identify materials that can be reconditioned, reused or recycled
		identify practices that reduce material waste
K-41.03.03L	demonstrate knowledge of training requirements to service <b>EV systems</b> and their <b>components</b>	identify training requirements to service <b>EV systems</b> and their <b>components</b>

K-41.03.04L	demonstrate knowledge of emerging technologies and practices pertaining to <b>EV systems</b> and their <b>components</b>	identify technologies and practices that contribute to net zero and carbon neutral commitments
		identify technologies that address emissions and pollution, and describe their characteristics and applications

## Range of Variables

**EV systems** include: A/C drives, series, parallel, fast charge, plug-in, extended range

**components** include: modules, inverters, high-voltage batteries, drive motors, converters, wiring, charging systems

**tools and equipment** include: specialized PPE, safety devices, specialized DMMs, electronic service tools, specialized hand tools (insulated tools), manufacturer-specific tools and equipment, insulation testers, lifting tools

**hazards** include: shocks, arc flash, sparks, falls, heavy weights, high working temperatures

# Appendix A

## Acronyms

ABS	anti-lock braking system
AED	automated external defibrillator
AGM	absorbed glass mat
API	American Petroleum Institute
APU	auxiliary power unit
CA	cranking amps
CAC	charge air cooler
CCA	cold cranking amps
DEF	diesel exhaust fluid
DMM	digital multimeters
DPF	diesel particulate filter
DRL	daytime running lights
ECM	electronic control module
EGR	exhaust gas recirculation
EPU	electronic processing unit
EV	electric vehicle
HVAC	heating, ventilation and air conditioning
MIG	metal inert gas
NO <sub>x</sub>	nitric oxide and nitrogen dioxide
OEM	original equipment manufacturer
OH&S	Occupational Health and Safety
PPE	personal protective equipment
PTO	power take-off
RC	reserve capacity
SAE	Society of Automotive Engineers
SCR	selective catalytic reduction
SDS	safety data sheets
SRS	supplemental restraint system
TCM	transmission control module
TDG	Transportation of Dangerous Goods
VECU	vehicle electronic control unit
VGT	variable geometry turbocharger
VIN	vehicle identification number
WHMIS	Workplace Hazardous Materials Information System

# Appendix B

## Tools and Equipment/Outils et équipement

### Personal Protective Equipment (PPE) and Safety Equipment/Équipement de protection individuelle (EPI) et équipement de sécurité

aprons	tablier
carbon monoxide sensors	détecteurs de monoxyde de carbone
coveralls (fire rated, high visibility)	combinaisons de travail
automated external defibrillator (AED)	défibrillateur externe automatisé (DEA)
emergency shower	douche d'urgence
exhaust ventilation	installation de ventilation
eye wash station	douche oculaire
face shields	écran facial
fall protection system	dispositifs antichute
fire blanket	couverture anti-feu
fire extinguisher	extincteurs
first aid kit	trousse de premiers soins
gloves (chemical, welding, latex, nitrile, heavy duty, cut resistant)	gants (de protection contre les produits chimiques, de soudeur, de latex, de caoutchouc nitrile, de qualité industrielle)
goggles	lunettes
guard rails	garde-corps
hard hats	casque de sécurité
hearing protection	protecteurs d'oreilles
high voltage protection (insulated gloves, clothing, tools)	équipement de protection contre la haute tension (gants, manteaux et outils isolés)
masks (dust, particulate, medical)	masques
respirators (organic materials, asbestos, other chemicals)	respirateur
safety boots	bottes
safety glasses	lunettes de sécurité
vehicle lock-out systems (tags and locks)	systèmes de verrouillage (étiquettes et verrous)
welding curtain	écran de soudeur
welding helmets	masque de soudeur
welding personal protective gear	équipement de protection personnel pour le soudage
wheel chocks	cale de roue

## Hand Tools/Outils à main

air blow gun	soufflette
bushing drivers	outil d'installation de coussinet
clamps	pincés
cutting equipment (side cutter, tube cutter, wire cutter, scissors, shears, razor knives)	outils de coupe (tranchant, coupe-tube, coupe-fil, ciseaux, cisailles, rasoirs)
emery paper/cloth	papier d'éméri
feeler gauges	calibres d'épaisseur
files	limes
filter wrenches	clés à filtre
flashlight	lampe de poche
hacksaw	scie métallique
hammers	marteaux
insulated tools	outils isolés
magnets	aimants
magnifying glass	loupes
mirrors	miroirs
pick set	extracteur à inertie
pipe wrench	serre-joints
pliers	pincés
pry bars	barre-leviers
pullers	extracteurs
punches and chisels	poinçons et ciseaux
saws	scies
scribes	pointes à tracer
scrapers	grattoirs
screwdrivers	tournevis
slide hammer	marteaux-piqueurs
sockets and ratchets	douilles et clés à cliquet
strong-arm / flex bar	bras de force/bras articulé
terminal tool set	ensemble d'outils pour extrémité de câbles
torque multiplier	multiplicateur de couple
torque wrench	clé dynamométrique
wire brush	brosse métalliques
wrenches	clés

## Power Tools/Outils mécaniques

air cut-off tools	outil à tronçonner pneumatique
air hammers	marteaux pneumatiques
ratchets (air, battery-operated)	cliquets pneumatiques
drills (air, battery-operated)	perceuses
impact gun (air, electric, battery-operated)	pistolet cloueur
grinders (air, electric, battery-operated)	meules
lighting devices (trouble lights, flood lights)	appareils d'éclairage (lampes baladeuses, projecteur pour illumination)
sanders (air, electric, battery-operated)	ponceuses
power saws (circular, hacksaws)	scie électrique
vacuum cleaner	aspirateur

## **Shop Equipment/Équipement d'atelier**

drill press	perceuse à colonne
headlight aimer	appareil de réglage des phares
oil catches	collecteur d'huile
parts washers	bac de dégraissage
pressure washer	laveuse à pression
presses (hydraulic, mechanical, portable hydraulic)	presses (hydrauliques, mécaniques, hydrauliques portables)
shop carts	chariots d'atelier
vice	étau
wheel alignment machine	machines de réglage de la géométrie des roues
wire wheel / bench grinder	brosse métallique à touret/meuleuse d'établi
work benches	établis

## **Measuring, Testing and Diagnostic Equipment/Appareils de mesure, d'essai et de diagnostic**

air conditioning recovery machines	station de récupération de réfrigérant
antifreeze tester	vérification d'antigel
back pressure tester	outil d'essai de contre-pression
battery load tester	testeur de batterie
black light	lumière noire
boost gauge	manomètre d'admission
brake drum gauge	jauge de tambour de frein
braking force test equipment	appareil d'essai de force de freinage
calipers (disc brake, inside, outside, Vernier)	compas (frein à disque, d'intérieur, d'extérieur, pied à coulisse)
circuit tester	vérificateur de circuit
compression gauges	compressiomètres
electronic service tools (computer, handheld)	équipement informatisé de diagnostic (ordinateur, portatif)
continuity tester	vérificateur de continuité
dial indicators	indicateur à cadrans
dynamometer	banc dynamométrique
electronic blowby tester	appareil d'essai électronique de gaz soufflé dans le carter
feeler gauge	jauges d'épaisseur
hydrometer	hydromètre
inductive pickup (amp clamp)	prise de position inductive
laser alignment tools	outil d'alignement laser
liner height protrusion gauge	indicateur de la hauteur de dépassement des chemises
micrometre (inside, outside, depth)	micromètre
multimeter	multiplicateur
opacity meter	opacimètre
plumb bob	fil à plomb
refractometer	réfractomètre
refrigerant identifier	identificateur de réfrigérant
pressure gauges	jauge de pression de gonflage
test light	lampe témoin
spark plug tester	vérificateur de bougies d'allumage
squares	équerres
straight edges	règles droites
tape measure	ruban à mesurer

telescopic gauge	jauge télescopique
temperature gauge (infrared, mechanical and electrical)	indicateur de température (infrarouge, mécanique et électrique)
timing light	lampe stroboscopique
tire gauge	manomètres
torque wrench	clé dynamométrique
trammel gauge	indicateur à compas
tread depth gauge	jauge de hauteur de filet
vacuum gauge	vacuomètre
video borescope	caméra vidéo sur un câble ou un trépied amovible
water manometer	manomètre à colonne d'eau

## **Welding and Cutting Equipment/Équipement de soudage et de coupage**

air arc welding equipment	équipement de soudage arc-air
MIG welding equipment	soudeuse MIG
oxyacetylene equipment	appareil d'oxycoupage
plasma cutter	machine de découpe plasma
propane torch	chalumeau à propane
soldering gun	pistolet à souder
SMAW welding equipment	soudeuses à baguette
TIG welding equipment	soudeuse TIG

## **Hoisting, Lifting and Staging Equipment/Équipement de lavage et d'accès**

axle lifts	lève-palette
blocking	cales
cranes (overhead, mobile)	grues
creepers	sommier roulant
fork lifts	chandelles
hoists	palans
jacks	crics
ladders	échelles
scaffolding/work platforms	échafaudages
safety stands	supports
steps	escabeaux
stools	tabourets



# Appendix C

## Glossary/Glossaire

<b>accessories</b>	components for the vehicle which enhance the operation or extend longevity; for example: greasing systems, radio, air conditioning and extra lights. Although some accessories are non-essential to the vehicle operation, they are sometimes required in extreme operating environments.	<b>accessoires</b>	composants du véhicule permettant d'en améliorer le fonctionnement ou d'en augmenter la durée de vie, par exemple : systèmes de lubrification, radio, climatisation et feux supplémentaires; même si certains accessoires ne sont pas essentiels au fonctionnement du véhicule, ils peuvent être requis dans des conditions d'utilisation extrêmes
<b>base engine</b>	assembled block and head including internal components and gear trains.	<b>moteur standard</b>	assemblage comprenant le bâti, la culasse, les composants internes et les trains d'engrenages
<b>diagnose</b>	tasks involved in inspecting, testing and determining faults in vehicle systems and components.	<b>effectuer un diagnostic</b>	tâches accomplies lors de l'inspection, des essais et de la détermination des défauts des systèmes et des composants du véhicule
<b>drive train</b>	portion that transfers power from the power source to the tires.	<b>transmission</b>	ensemble mécanique transmettant la puissance du volant d'inertie jusqu'aux pneus
<b>driveline</b>	part of the drive train that couples the power source to the driven component.	<b>arbre de transmission</b>	arbre reliant la source d'énergie au composant entraîné
<b>electrical systems</b>	starting, charging, lighting and accessory circuits without computer control modules.	<b>système électrique</b>	ensemble des circuits de démarrage, de charge, d'éclairage et d'accessoires non pourvus de modules de commande informatisés
<b>electronic control module (ECM)</b>	module which controls functions of a vehicle; some common ECMs are EPU (electronic processing units), ECUs (electronic control units), VECUs (vehicle electronic control units), TCMs (transmission control modules), ABS (anti-lock braking systems).	<b>module de commande électronique</b>	module électronique commandant les fonctions d'un véhicule; parmi les modules de commande électronique les plus courants figurent les blocs de traitement électronique, les blocs de commande électronique et les blocs de commande électronique du véhicule
<b>electronic systems</b>	electrical systems operated via computerized electronic control modules and related sensors and wiring.	<b>système électronique</b>	ensemble des dispositifs électriques commandés par l'entremise de modules de commande électronique informatisés, de leurs capteurs et de leurs câbles

<b>high voltage</b>	any voltage that is 50 V and above	<b>haute tension</b>	toute tension de 50 V et plus
<b>landing gear</b>	components which are used to support the weight of a semi-trailer when disconnected from the vehicle.	<b>stabilisateur</b>	composants utilisés pour supporter le poids de la remorque lorsque celle-ci n'est pas fixée à un véhicule
<b>power take-off (PTO)</b>	device that couples and uncouples a power source to transfer power to auxiliary systems.	<b>prise de force</b>	dispositif qui relie une source d'énergie aux systèmes auxiliaires ou qui les sépare pour transmettre de l'énergie à ces systèmes
<b>repair</b>	activities which include replacement, rebuild, or repairing of truck and transport vehicles and components.	<b>réparation</b>	ensemble des activités comprenant le remplacement, la remise en état ou la réparation des composants des camions et véhicules de transport
<b>sensory inspection</b>	diagnosing or inspecting using sight, sound, smell and feel.	<b>inspection sensorielle</b>	diagnostiquer ou inspecter en utilisant les sens de la vision, de l'ouïe, de l'odorat et du toucher
<b>service</b>	activities which include adjustment, lubricating and general maintenance of truck and transport vehicles and components.	<b>maintenance</b>	ensemble des activités comprenant la réparation, le remplacement, la reconstruction, l'ajustement et l'entretien de camions, de véhicules de transport et de leurs composants
<b>spark ignition system</b>	system which controls a small amount of electrical power to create and transmit, through a step-up transformer, a high voltage to a sparking device which in turn begins ignition.	<b>allumage par étincelle</b>	circuit commandant un faible courant électrique pour produire et transmettre, par l'entremise d'un transformateur élévateur, un courant haute tension à un dispositif créant des étincelles pour lancer la séquence d'allumage
<b>suspension</b>	components which absorb road surface irregularities to smooth vehicle ride; it is designed to permit controlled wheel movement over irregular surfaces; basic types include spring, air and rubber block.	<b>suspension</b>	ensemble des composants qui absorbent les irrégularités de la route pour permettre au véhicule de rouler en douceur; elle est conçue pour permettre le mouvement contrôlé des roues sur des surfaces irrégulières; les principaux types de suspension sont les suspensions à ressorts, pneumatiques et à bloc en caoutchouc