PROGRAM PROGRAMME
EXCELLENCE
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National Occupational Analysis

Heavy Duty Equipment Technician

2013

CANADIAN STANDARD OF EXCELLENCE FOR SKILLED TRADES

INTERPROVINCIAL STANDARD
CANADA
NORME INTERPROVINCIALE

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Employment and Social Development Canada
Emploi et Développement social Canada

Canada

Occupational Analyses Series

Heavy Duty Equipment Technician

2014

Trades and Apprenticeship Division	Division des métiers et de l'apprentissage
Workplace Partnerships Directorate	Direction des partenariats en milieu de travail
National Occupational Classification:	7312
Disponible en français sous le titre :	Mécanicien/mécanicienne d'équipement lourd

This publication is available online: www.red-seal.ca

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PDF
Cat. No.: Em15-1/6-2014E-PDF
ISBN: 978-1-100-24748-9

FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis as the national standard for the occupation of Heavy Duty Equipment Technician.

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) sponsors a program, under the guidance of the CCDA, to develop a series of NOAs

The NOAs 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 curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and,
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

ACKNOWLEDGEMENTS

The CCDA and ESDC wish to express sincere appreciation for the contribution of the many tradespersons, industrial establishments, professional associations, labour organizations, provincial and territorial government departments and agencies, and all others who contributed to this publication.

Special acknowledgement is extended to the following representatives from the trade who attended a national workshop to develop the previous edition of this NOA in 2009

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This 2014 edition of the NOA was reviewed, updated and validated by industry representatives from across Canada to ensure that it continues to represent the skills and knowledge required in this trade. The coordinating, facilitating and processing of this analysis were undertaken by employees of the NOA development team of the Trades and Apprenticeship Division of ESDC. The host jurisdiction of Prince Edward Island also participated in the development of this NOA.

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STRUCTURE OF ANALYSIS

To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

Blocks	the largest division within the analysis that is comprised of a distinct set of trade activities
Tasks	distinct actions that describe the activities within a block
Sub-Tasks	distinct actions that describe the activities within a task
Key Competencies	activities that a person should be able to do in order to be called 'competent' in the trade

The analysis also provides the following information:

Trends	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
Related Components	a list of products, items, materials and other elements relevant to the block
Tools and Equipment	categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A
Context	information to clarify the intent and meaning of tasks
Required Knowledge	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the analysis are described as follows:

Appendix A — Tools and Equipment	a non-exhaustive list of tools and equipment used in this trade
Appendix B — Glossary	definitions or explanations of selected technical terms used in the analysis
Appendix C — Acronyms	a list of acronyms used in the analysis with their full name
Appendix D — Block and Task Weighting	the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam
Appendix E — Pie Chart	a graph which depicts the national percentages of exam questions assigned to blocks
Appendix F — Task Profile Chart	a chart which outlines graphically the blocks, tasks and sub-tasks of this analysis

DEVELOPMENT AND VALIDATION OF ANALYSIS

Development of Analysis

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from Human Resources and Skills Development Canada. This draft analysis 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.

Draft Review

The National Occupational Analysis (NOA) development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

Validation and Weighting

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

BLOCKS	Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade.
TASKS	Each jurisdiction assigns a percentage of exam questions to each task within a block.
SUB-TASKS	Each jurisdiction indicates, with a YES or a 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 NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on the common core sub-tasks identified through this validation process.

Definitions for Validation and Weighting

YES	sub-task performed by qualified workers in the occupation in a specific jurisdiction
NO	sub-task not performed by qualified workers in the occupation in a specific jurisdiction
NV	analysis Not Validated by a province/territory
ND	trade Not Designated in a province/territory
NOT COMMON CORE (NCC)	sub-task, task or block performed by less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
NATIONAL AVERAGE %	average percentage of questions assigned to each block and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

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

ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of manufacturers, government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) Regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis

SCOPE OF THE HEAVY DUTY EQUIPMENT TECHNICIAN TRADE

"Heavy Duty Equipment Technician" is this trade's official Red Seal occupational title approved by the Canadian Council of Directors of Apprenticeship. This analysis covers tasks performed by heavy duty equipment technicians whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Heavy Duty Equipment Mechanic													
Heavy Duty Equipment Mechanic (Construction)					✓								
Heavy Duty Equipment Mechanic (Non-Construction)					✓								
Heavy Duty Equipment Technician	✓	✓	✓			✓	✓	✓		✓	✓		✓
Heavy Duty Equipment Technician (Off Road)												✓	
Heavy Duty Equipment Technician - Heavy Duty Equipment Mechanic (Off Road)									✓				
Heavy Equipment Service Technician				✓									

Heavy duty equipment technicians inspect, diagnose, repair, adjust, overhaul, maintain, test and verify heavy duty equipment.

Heavy duty equipment technicians are employed by companies that own and operate heavy equipment, heavy equipment dealerships, rental and service companies, construction contractors, forestry companies, mining companies, ski hills and government departments that service and repair their own equipment. Technicians can work in the following industries: construction, forestry, mining, marine, oil and gas, material handling, landscaping and land clearing. Many heavy duty equipment technicians have experience on a wide variety of equipment types and manufacturers.

It is recognized that heavy duty equipment technicians are increasingly working with alternative prime movers such as electrical. However, the focus of this analysis is based on the internal combustion engine as the prime mover.

Heavy duty equipment technicians work in the full range of environmental conditions: from service shops to remote sites where inclement weather can affect the technician's performance of his/her duties. Good physical condition and agility are important because the work often requires considerable standing, bending, crawling, lifting, climbing, pulling and reaching.

Due to the size and complexity of the equipment, safety is of prime importance. Technicians must be conscious of the impact on people, equipment, work area and environment when performing their work. There is risk of injury when working with heavy equipment.

Some important attributes of the heavy duty equipment technician are: mechanical and mathematical aptitude, an ability to work with computers, an ability to communicate effectively, to work with little or no supervision, to work as a team player and to plan and work sequentially.

This analysis recognizes similarities or overlaps in the work of other tradespersons, such as automotive service technicians, agricultural equipment technicians, truck and transport mechanics, millwright, powerlift truck technicians and transport trailer technicians.

OCCUPATIONAL OBSERVATIONS

Some significant observations and trends emerged from the national occupational analysis of the heavy duty equipment technician occupation. These observations and trends are briefly outlined in this section.

Computer software is increasingly being used for diagnostics, function calibration, programming, service and parts information. The use of computerized equipment has raised the level of troubleshooting ability required by technicians. Onboard electronic monitroring systems are being used to increase efficiency, reliability and performance. This in turn requires a higher level of training for technicians.

Satellite monitoring and diagnosing of machinery has been introduced and is becoming more widespread. The use of Global Positioning System (GPS) and wireless technology has been introduced to improve equipment operation and repair. The use of remote control equipment is increasing in the mining and construction sectors.

Regular predictive and preventative maintenance is being emphasized to reduce downtime and costs related to major failures. Improved oils and filtering are being used to extend oil life in order to reduce the amount of environmental waste.

More emphasis is being placed on the safe handling, disposal, storage and recycling of toxic or environmentally hazardous materials. There is concern regarding diesel engine emissions produced. Changes to regulations and emission standards will have an impact on the way diesel engines are constructed and on the duties of technicians. Different issues and vehicle faults may arise because of the new designs of these engines and components.

BLOCK A COMMON OCCUPATIONAL SKILLS

Context This block includes activities that heavy duty equipment technicians perform throughout their trade.

Trends Documentation is increasingly becoming electronic. There is a greater emphasis on safety in this trade. Because of renewed environmental considerations, waste-handling and anti-spill procedures are more stringent. Remote fluid analysis checks using plug-in ports to collect fluids have become more common. There is a greater variety of fluids such as bio-fuels, synthetic oils, vegetable based oil and propane being used in heavy duty equipment.

Related Components All components apply.

Tools and Equipment See Appendix A.

Task 1 Uses and maintains tools and equipment.

Required Knowledge

K 1	types of tools such as hand tools and power tools
K 2	types of measuring and testing tools such as gauges, meters and precision tools
K 3	government regulations
K 4	training requirements for rigging, lifting and access equipment
K 5	hoisting, rigging and lifting equipment such as slings, spreader bars and load levellers
K 6	access equipment such as personnel lifts, ladders, scissor lifts, and scaffolding
K 7	applications of tools and equipment
K 8	imperial and metric measuring systems
K 9	capacity and limitations of lifting equipment
K 10	personal protective equipment and safety equipment (PPE)

Sub-task

A-1.01 Maintains tools and equipment.

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

Key Competencies

A-1.01.01	clean and lubricate tools and equipment
A-1.01.02	inspect tools to determine wear and damage
A-1.01.03	organize and store tools and equipment
A-1.01.04	test and calibrate measuring tools such as micrometers and calipers to ensure they are accurate
A-1.01.05	check devices such as hoisting, lifting and access equipment for required inspection tags and ratings
A-1.01.06	notify appropriate personnel of defective tools and equipment so that they get repaired or replaced

Sub-task

A-1.02 Uses hoisting and lifting equipment.

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

Key Competencies

A-1.02.01	locate component weights and lift points
A-1.02.02	determine hoisting and rigging equipment maximum capacities by referring to tags and specifications
A-1.02.03	inspect lifting equipment and components to be lifted for deficiencies such as cracked lifting lugs, damaged eye bolts and frayed straps or cables
A-1.02.04	communicate lift through hand signals or radio communication
A-1.02.05	implement safety practices such as securing lift area and using spotters
A-1.02.06	select and use rigging equipment and components such as slings, spreader bars and load levellers according to regulations and specifications
A-1.02.07	obtain required clearances, certification/licensing
A-1.02.08	identify hoisting and lifting hazards such as power lines, unstable ground and environmental conditions

Sub-task

A-1.03 Operates access equipment.

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

Key Competencies

A-1.03.01	determine hazards in location such as uneven ground, overhead lines and other hoisting devices on site
A-1.03.02	ensure equipment is appropriate for task at hand
A-1.03.03	obtain clearances, certification and licenses for use of access equipment
A-1.03.04	use access equipment safety procedures such as fall protection, pre-operational tests and environmental checks
A-1.03.05	communicate lift through hand signals, verbal or radio communication

Sub-task

A-1.04 Uses personal protective equipment (PPE) and safety equipment.

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

Key Competencies

A-1.04.01	select PPE and safety equipment as required for task at hand and work surroundings
A-1.04.02	identify site hazards and regulations requiring the use of PPE and safety equipment
A-1.04.03	inspect, maintain PPE and safety equipment
A-1.04.04	apply local, provincial and national safety regulations such as WHMIS and Transport of Dangerous Goods (TDG)

Task 2 Performs general maintenance and inspections.

Required Knowledge

K 1	types of fluids such as engine, drivetrain and hydraulic
K 2	fluid ratings such as viscosity and quality
K 3	fluid handling, storage and disposal procedures and regulations
K 4	filter ratings
K 5	fluid sample analysis
K 6	imperial and metric fasteners and measuring systems
K 7	types and grades of fasteners
K 8	torque specifications
K 9	different tightening methods such as torque turn, hydraulic torque and straight torque
K 10	chemical reactions involved in sealants and adhesives
K 11	types of sealing devices such as gaskets, o-rings and packing
K 12	types of adhesives
K 13	types of hoses, tubing, piping and fittings such as Society of Automotive Engineers (SAE), Joint Industry Conference (JIC), British Standard Pipe (BSP), o-ring boss (ORB) and o-ring flange (ORF)
K 14	bearing materials and types such as ball, tapered, roller and plain or sleeve
K 15	bearing specifications
K 16	seal types such as, static and dynamic
K 17	seal materials such as steel, neoprene and nitrile
K 18	types of safety features such as lighting and warning devices, fire suppression systems, lock-out bars and operator access features
K 19	operation of safety features
K 20	government regulations such as roll-over protective structure (ROPS), FOPS and OPS
K 21	mechanical and electronic lock-out systems
K 22	audible and visual warning systems and devices
K 23	manufacturers' service recommendations
K 24	preventative maintenance requirements
K 25	machine operation and controls
K 26	licensing and authorization requirements for operation and repair of equipment
K 27	equipment and component limitations

K 28	pre-start and walk around inspection
K 29	parking and shut-down procedures

Sub-task

A-2.01 Maintains fluids.

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

Key Competencies

A-2.01.01	check fluids such as fuel, lubricants, coolants, transmission fluids and hydraulic fluids according to manufacturers' specifications
A-2.01.02	select types and grades of fluids and lubricants for the application according to manufacturers' specifications and fluid capacity
A-2.01.03	change fluids and filters, and inspect used filters for signs of contamination
A-2.01.04	perform sensory inspection of fluids to check for impurities and improper mixing
A-2.01.05	use diagnostic equipment to test fluid properties such as coolant strength, oil pour point and temperature
A-2.01.06	maintain a clean working environment in order to prevent contamination of systems
A-2.01.07	select and use additives such coolant charge filters, diesel fuel conditioners and limited slip additives

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Sub-task

A-2.02 Services fasteners, sealing devices, adhesives and gaskets.

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

Key Competencies

A-2.02.01	identify types, sizes and grades of fasteners, sealing devices, adhesives and gaskets
A-2.02.02	chase threads and repair with tap and dies
A-2.02.03	remove broken fasteners using methods such as drilling, heating and welding
A-2.02.04	install thread inserts to create original bolt size
A-2.02.05	select types of threads such as coarse and fine used for different applications

A-2.02.06	torque fasteners to manufacturers' specified torque rating
A-2.02.07	prepare surfaces to receive sealing devices, adhesives and gaskets according to manufacturers' specifications
A-2.02.08	select and apply sealing compounds to lock fasteners
A-2.02.09	select and apply sealing compounds to seal, to repair imperfections or to aid gaskets
A-2.02.10	identify types of gaskets such as pre-formed composite gaskets, paper, cork-rubber and metal
A-2.02.11	make gaskets according to task requirements
A-2.02.12	install gaskets according to manufacturers' specifications in order to ensure tight seal and prevent damage to the gasket

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Sub-task

A-2.03 Services hoses, tubing, piping and fittings.

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

Key Competencies

A-2.03.01	identify ratings and applications of hoses, tubing, piping and fittings
A-2.03.02	identify types of fittings such as reusable and crimp
A-2.03.03	crimp fittings using crimping tools and dies
A-2.03.04	bend and flare tubing and piping using hand and power tools
A-2.03.05	perform preventative maintenance of hoses, tubing, piping and fittings by checking for deficiencies such as chafed hoses, bubbling and leaks
A-2.03.06	remove and replace hoses, tubing, piping and fittings
A-2.03.07	fabricate hoses, tubing and piping to specifications by cutting to length, cleaning interior and verifying the crimp of fittings

Sub-task

A-2.04 Services bearings and seals.

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

Key Competencies

A-2.04.01	select and use tools and equipment such as hydraulic presses, heating equipment, cooling equipment, and seal and bearing drivers
A-2.04.02	remove and install bearings
A-2.04.03	remove and install seals such as front and rear main seals, cam shaft seals and accessory drive seals
A-2.04.04	lubricate bearings and seals as required by manufacturers' specifications
A-2.04.05	inspect bearings and seals for leaks, stiffness and wear
A-2.04.06	identify types of seals for the task such as lip seals and dual cone
A-2.04.07	renew shaft using wear sleeve to repair seal surface area
A-2.04.08	set up bearing according to manufacturers' specifications such as pre-load and end play

Sub-task

A-2.05 Services safety features.

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

Key Competencies

A-2.05.01	perform function test and maintenance of safety features such as restraints and warning devices
A-2.05.02	report defects of safety features in order to ensure the defects are corrected
A-2.05.03	recognize criteria for repair or replacement of safety features
A-2.05.04	repair safety features according to manufacturers' and government specifications
A-2.05.05	remove and replace safety features according to manufacturers' and government specifications
A-2.05.06	adjust safety features according to operating manufacturers' specifications and government regulations

Sub-task

A-2.06 Performs scheduled maintenance procedures.

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

Key Competencies

A-2.06.01	follow manufacturers' and company guidelines for scheduled maintenance
A-2.06.02	record deficiencies with equipment in order to arrange for repair
A-2.06.03	determine working condition and operating environment of equipment and adjust regular maintenance accordingly
A-2.06.04	refer to previous maintenance records for maintenance and repair history
A-2.06.05	consult with equipment operator or owner and refer to operator records for maintenance and repair requirements
A-2.06.06	verify maintenance and repair
A-2.06.07	maintain service records

Sub-task

A-2.07 Identifies operational faults.

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

Key Competencies

A-2.07.01	verify complaints with operating equipment
A-2.07.02	determine abnormal operating characteristics such as squealing, knocking and vibrations
A-2.07.03	interpret source and cause of abnormal operating characteristics
A-2.07.04	select and use diagnostic and testing tools and equipment such as scanners, gauges and onboard diagnostic equipment
A-2.07.05	record deficiencies with equipment in order to arrange for repair

Sub-task

A-2.08 Performs operational check-out.

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

Key Competencies

A-2.08.01	perform walk-around inspection and start-up procedures
A-2.08.02	verify working condition of operating equipment
A-2.08.03	perform equipment shut-down procedures
A-2.08.04	record and report findings from operational check-out

Task 3 Organizes work.

Required Knowledge

K 1	types of service information
K 2	technical service bulletins (updates)
K 3	onboard and external diagnostic systems
K 4	schematic types and function
K 5	factory support
K 6	data storage and transfer methods
K 7	government regulations, and industry and company standards
K 8	personal and company liability
K 9	types of service-related documents
K 10	types of safety-related documents such as Material Safety Data Sheet (MSDS) and Commercial Vehicle Inspection Program (CVIP)
K 11	trade terminology
K 12	WHMIS
K 13	jurisdictional and company safety practices and regulations
K 14	location of safety equipment such as first aid equipment, fire extinguishers and eye wash stations
K 15	parts lists and requisition procedures

Sub-task

A-3.01 Uses documentation and reference materials.

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

Key Competencies

A-3.01.01	read manuals such as operator, service, parts and safety manuals in order to locate required information
A-3.01.02	use computers to locate required information such as warranty, service and parts
A-3.01.03	interpret and apply technical information to situation
A-3.01.04	interpret schematics and drawings
A-3.01.05	uses on-board and external diagnostic systems

Sub-task

A-3.02 Completes documentation.

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

Key Competencies

A-3.02.01	record technical information such as warranty claims, service records, preventative maintenance records and failure analysis using photographs
A-3.02.02	record work-related information such as technician hours worked, machine hours, vehicle identification number (VIN), parts used and task description
A-3.02.03	complete safety-related documents such as accident reports according to jurisdictional and company regulations
A-3.02.04	report completion of documentation to management

Sub-task

A-3.03 Communicates with others.

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

Key Competencies

A-3.03.01	mentor apprentices in order to pass on trade skills and practices
A-3.03.02	convey technical information in layperson terms
A-3.03.03	use communication tools and equipment such as computers, cell phones, and satellite phones
A-3.03.04	obtain technical information from operator through questioning
A-3.03.05	collaborate with other technicians in order to solve problems
A-3.03.06	give and follow directions through effective listening and communication

Sub-task

A-3.04 Prepares job action plan.

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

Key Competencies

A-3.04.01	use procedures for recording equipment disassembly to assist in assembly such as taking pictures or video, tagging and marking
A-3.04.02	analyze tasks required prior to disassembly
A-3.04.03	determine tool and equipment requirements for diagnosis and repair
A-3.04.04	plan for parts required for repair and determine availability of parts
A-3.04.05	plan order of maintenance procedures such as disassembly, assembly and repair
A-3.04.06	refer to manual if available for an overview of repair procedures
A-3.04.07	plan repair space for all operations such as hoisting requirements, cleanliness, and time constraints
A-3.04.08	consult with experienced technicians and other trades such as machinists, welders and electricians
A-3.04.09	estimate repair times and finish dates
A-3.04.10	organize travel schedule in order to make most effective use of time

Sub-task

A-3.05 Maintains safe work environment.

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

Key Competencies

A-3.05.01	keep work area clean
A-3.05.02	use lock-out and tag-out procedures to prevent unwanted or unsafe operation of equipment
A-3.05.03	use anti-spill kits and procedures
A-3.05.04	apply local, provincial and national safety regulations such as WHMIS and TDG
A-3.05.05	recognize worksite hazards that require the use of PPE and safety equipment
A-3.05.06	recognize potential hazards such as noise level, air quality, and flammable and explosive materials
A-3.05.07	report hazardous conditions and work practices to prevent workplace injuries
A-3.05.08	clean, handle, store, remove and dispose of hazardous materials such as batteries and waste products according to jurisdictional regulations
A-3.05.09	perform safety inspection of equipment and surrounding work area
A-3.05.10	ensure all equipment is stored, parked on leveled ground and attachments lowered
A-3.05.11	communicate work-related information such as tagging out and noting work in progress

Task 4 Performs routine trade activities.

Required Knowledge

K 1	government regulations
K 2	safe handling procedures for compressed gas cylinders and liquid nitrogen
K 3	cutting equipment such as gas, plasma and arc/air
K 4	types of fuel gases such as acetylene and propane
K 5	properties of metals and reactions to heat, cold and chemicals
K 6	types of component heating methods such as torch (acetylene or propane) induction heaters, ovens and heat lamps

K 7	expansion and contraction of metals through heating and cooling
K 8	types of component cooling methods such as CO_2 and liquid nitrogen
K 9	risks associated with heating equipment
K 10	types of cleaning equipment and procedures
K 11	types of cleaning agents
K 12	reactions of materials to specific cleaning agents
K 13	safe handling, storage and disposal of cleaning agents
K 14	safe handling, storage and disposal of waste

Sub-task

A-4.01 Heats materials.

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

Key Competencies

A-4.01.01	use component heating methods such as using induction heaters, ovens, heat lamps and torches
A-4.01.02	determine required heating of materials according to manufacturers' specifications
A-4.01.03	measure heat of metals using methods such as using heat stick, using infrared temperature gun and measuring with temperature probe

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Sub-task

A-4.02 Cools materials.

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

Key Competencies

A-4.02.01	use component cooling methods such as using water, CO_2 and liquid nitrogen
A-4.02.02	determine required cooling of materials according to manufacturers' specifications
A-4.02.03	measure cooling of metals using methods such as using a heat stick, using infrared temperature gun and measuring with temperature probe

Sub-task

A-4.03 Cuts materials.

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

Key Competencies

A-4.03.01	select and use cutting tools and equipment such as torches, cutting discs, plasma cutters, hack saws and air/arc cutters
A-4.03.02	prepare work environment and material to be cut
A-4.03.03	recognize limitations in work environment such as gases, enclosed spaces and other personnel
A-4.03.04	determine composition and function of material to be cut
A-4.03.05	recognize manufacturers' prohibition of cutting components such as ROPS, FOPS and OPS

Sub-task

A-4.04 Welds materials.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	no	yes	NV	NV	NV

Key Competencies

A-4.04.01	select and use welding tools and equipment such as torches, metal inert gas (MIG) welders, and shielded metal arc welding (SMAW) equipment
A-4.04.02	prepare work environment and material to be welded
A-4.04.03	recognize jurisdictional limitations, certification and licensing requirements for different types of welding
A-4.04.04	select welding material as required by the task
A-4.04.05	recognize limitations in work environment such as gases, enclosed spaces and other personnel
A-4.04.06	determine composition and function of material to be welded
A-4.04.07	isolate all electronics on equipment by disconnecting ground source or using surge protector to prevent damage
A-4.04.08	isolate component to be welded

A-4.04.09	place ground as close to weld as possible to avoid unwanted arcing and heating through components such as bearings, bushings, cylinders and seals
A-4.04.10	recognize manufacturers' prohibition of welding components such as ROPS, FOPS and OPS

Sub-task

A-4.05 Cleans parts and materials.

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

Key Competencies

A-4.05.01	select cleaning agents according to manufacturers' specifications, MSDS descriptions and compatibility with material to be cleaned
A-4.05.02	prepare surface for cleaning
A-4.05.03	select and use cleaning tools and equipment such as air scrapers, pressure washers, and abrasives
A-4.05.04	immerse parts in dip tanks and parts washers
A-4.05.05	dispose of cleaning agents according to government regulations and manufacturers' specifications

BLOCK B ENGINES AND ENGINE SUPPORT SYSTEMS

Context	Heavy duty equipment technicians must be able to efficiently diagnose and repair engines and engine sub-systems to maintain equipment performance and reliability to reduce equipment down time. All diagnostic and repair tasks must be performed according to manufacturers' specifications. When working on high pressure fuel systems, technicians must observe additional safety procedures.
Trends	Engine and supporting systems are becoming more sophisticated and complex due to emission requirements. Electronics are prevalent throughout engines and supporting systems, and technicians increasingly need a high level of computer skills and electronic diagnostic abilities. Due to environmental concerns, manufacturers are moving towards the use of improved or new technologies such as after treatment devices, variable rate turbo charging, high pressure common rail fuel injection and alternative fuels to reduce emission levels.
Related Sub-systems	Base engines, lubrication systems, cooling systems, fuel systems, intake and exhaust systems, engine control systems, emission control systems.
Related Components (include, but not limited to)	**Base engines:** heads, block, pistons, connecting rods, crankshaft, wrist pins, bearings, camshaft, harmonic balancers, gears, lifters, covers, gaskets, seals, push rods, valves, rockers, springs, flywheel housing, flywheel. **Lubrication systems:** oil pumps, filters, valves, coolers, lubricants, oil lines, oil sump, bearings, bushings, gears, seals, gaskets. **Cooling systems:** water pumps, piping, hoses, clamps, radiators, thermostat, shutters, shrouds, fans, fan drive, regulators, coolant, heat exchangers. **Intake and exhaust systems:** muffler, tubing, piping, manifold, air cleaner, clamps, superchargers, turbochargers (variable geometry turbocharging), coolers, pre-cleaners, restriction indicators, ether injection.

Fuel systems: fuels, fuel filter, regulators, tank, lines, lift pump, mechanical and electronic injectors, pumps, fuel injector pumps, nozzles, injector tips, hoses, tubes, water separator, governors, timing and spark advance, seals, gaskets, sensors, solenoids, wiring, software.

Engine control system: electronic control modules (ECM), software, wiring, coils, spark plugs, solenoids, sensors, linkages, pedals, cables, potentiometer, engine protection devices.

Emission control system: selective catalytic reduction (SRC), diesel oxidation catalyst (DOC), diesel particulate filters (DPF), scrubber, exhaust gas recirculation (EGR) components, positive crankcase ventilation (PCV) valves, exhaust gas coolers, variable geometry turbochargers.

Tools and Equipment

See Appendix A.

Task 5 Diagnoses engines and engine support systems.

Required Knowledge

K 1	operational test methods such as load, no-load and governed speeds
K 2	manufacturers' engine ratings
K 3	types, viscosity and quality of fluids
K 4	fuel grade, condition and types such as bio-fuels, diesel, compressed natural gas (CNG) and liquefied propane gas (LPG)
K 5	spark ignition systems and components such as module boxes, coils, wires and spark plugs
K 6	engine types, operation, components and specifications
K 7	lubrication system types, operation, components and specifications
K 8	cooling system types, operation, components and specifications
K 9	intake and exhaust system types, operation, components and specifications
K 10	fuel system types, operation, components and specifications
K 11	engine control system types, operation, components and specifications
K 12	emission control system types, operation, components and specifications
K 13	manufacturers' safety procedures regarding high pressure fuel systems
K 14	types of starting aids

Sub-task

B-5.01 Diagnoses base engine.

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

Key Competencies

B-5.01.01	select and use on-board diagnostic tools such as scan tool, compression testers and measuring devices
B-5.01.02	perform tests such as cylinder leak-down, compression and vacuum
B-5.01.03	identify and distinguish sources of noises, vibrations and harshness (NVH) in engine components such as valve train, pistons and crankshaft
B-5.01.04	remove and disassemble components to identify problem
B-5.01.05	recognize worn, damaged and defective components such as worn camshafts, bearings and rings
B-5.01.06	inspect valve timing and adjustment
B-5.01.07	take measurements of base engine components and compare to manufacturers' specifications
B-5.01.08	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

B-5.02 Diagnoses lubrication systems.

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

Key Competencies

B-5.02.01	select and use diagnostics tools such as flow meters, pressure gauges, temperature gauges and onboard diagnostic tools
B-5.02.02	identify type of lubricant to be used according to manufacturers' specifications and operating conditions
B-5.02.03	perform sensory inspections to identify symptoms such as leaks and damaged or worn components
B-5.02.04	remove and disassemble components to identify problem
B-5.02.05	take oil sample and interpret test results such as contamination, wear elements and trends

B-5.02.06	test system pressure according to manufacturers' specifications to locate faults such as blockages, leakages and worn parts
B-5.02.07	identify components of lubrication systems such as oil pump, regulator and pressure relief valve
B-5.02.08	inspect lubrication system components for wear, damage and defects
B-5.02.09	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

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Sub-task

B-5.03 Diagnoses cooling systems.

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

Key Competencies

B-5.03.01	select and use diagnostic tools such as coolant testers, air flow meter and coolant pressure tester
B-5.03.02	pressure test cooling systems to identify fluid and pressure leaks
B-5.03.03	perform sensory inspections to identify defects such as leaks and radiator obstructions
B-5.03.04	remove and disassemble components to identify problem
B-5.03.05	determine cooler condition for reuse
B-5.03.06	test coolant concentration and condition
B-5.03.07	test radiator efficiency for air flow and heat transfer
B-5.03.08	inspect and test cooling system components such as water pump, fan, belts and shrouds for defects
B-5.03.09	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

B-5.04 Diagnoses intake and exhaust systems.

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

Key Competencies

B-5.04.01	identify equipment's type of intake and exhaust system and components
B-5.04.02	select and use diagnostic tools such as pressure gauges and infrared temperature gun
B-5.04.03	perform engine performance tests according to manufacturers' specifications
B-5.04.04	perform sensory inspections to identify symptoms such as excessive noise, damaged components and excessive heat
B-5.04.05	inspect turbo chargers
B-5.04.06	remove and disassemble components to identify problem
B-5.04.07	inspect intake and exhaust systems for leaks or blockages using methods such as turbo boost test and air pressure test
B-5.04.08	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

B-5.05 Diagnoses fuel systems.

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

Key Competencies

B-5.05.01	select and use diagnostic tools such as pressure and vacuum gauges
B-5.05.02	perform engine performance tests according to manufacturers' specifications
B-5.05.03	perform visual and auditory inspections according to high pressure system protocols to identify symptoms such as fuel leaks, aeration and abnormal exhaust smoke
B-5.05.04	remove and disassemble components to identify problem
B-5.05.05	perform fuel pressure tests according to manufacturers' specifications
B-5.05.06	identify fuel grade, condition and type such as diesel, CNG and LPG
B-5.05.07	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

B-5.06 Diagnoses engine control systems.

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

Key Competencies

B-5.06.01	select and use diagnostic tools
B-5.06.02	identify engine control systems types such as mechanical or electrical
B-5.06.03	identify spark ignition system components
B-5.06.04	perform visual and auditory inspections to identify defects such as throttle linkage wear and linkage binding
B-5.06.05	remove and disassemble components to identify problem
B-5.06.06	review ECM diagnostic information such as fault codes, parameters and software version
B-5.06.07	perform engine control system tests such as solenoid test, calibration test and injector cut-out test
B-5.06.08	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications
B-5.06.09	perform starting aid tests such as glow plug, intake heater, block heater or ether injection

Sub-task

B-5.07 Diagnoses emission control systems.

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

Key Competencies

B-5.07.01	identify equipment's type of emission system and components
B-5.07.02	remove and disassemble components to identify problem
B-5.07.03	test exhaust gas to determine emission compliance according to regulations
B-5.07.04	test components of emission control system such as sensors, EGR valve, PCV, diesel particulate filter and selective catalytic reduction (SCR) according to manufacturers' specifications
B-5.07.05	perform visual and auditory inspections to identify symptoms such as excessive smoke and damaged components

B-5.07.06	select and use on-board diagnostic tools such as gas analyser, computer and multimeters
B-5.07.07	interpret and analyze results of tests and inspections to determine required repair according to manufacturers' specifications

Task 6 Repairs engines and engine support systems.

Required Knowledge

K 1	manufacturers' specifications
K 2	engine types, operation, components and specifications
K 3	lubrication system types, operation, components and specifications
K 4	cooling system types, operation, components and specifications
K 5	intake and exhaust system types, operation, components and specifications
K 6	fuel system types, operation, components and specifications
K 7	engine control system types, operation, components and specifications
K 8	emission control system types, operation, components and specifications
K 9	specified system performance to manufacturers' specifications
K 10	types, viscosity and quality of fluids
K 11	fuel grade, condition and type such as biofuels, diesel, CNG and LPG
K 12	spark ignition systems and components such as coils, wires and spark plugs
K 13	cold starting aids such as intake heaters, block heaters, ether injection and glow plugs
K 14	manufacturers' safety procedures regarding high pressure fuel systems

Sub-task

B-6.01 Repairs base engines.

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

Key Competencies

B-6.01.01	select and use repair tools and equipment such as hand tools, plastigauge, straight edge and micrometer
B-6.01.02	remove, disassemble and inspect engine components such as cylinder heads, cylinder liners, crank shaft and cam shaft for conditions such as damage and wear
B-6.01.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
B-6.01.04	remove, replace, recondition or service components according to manufacturers' procedures and specifications
B-6.01.05	reassemble engine components and perform measurements
B-6.01.06	perform valve timing adjustment
B-6.01.07	torque components according to sequence and specifications
B-6.01.08	perform mechanical engine timing procedures
B-6.01.09	adjust base engine components and parts
B-6.01.10	perform pre-lubrication and priming procedures
B-6.01.11	install engine and engine components
B-6.01.12	complete repair by verifying system's function and performance

Sub-task

B-6.02 Repairs lubrication systems.

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

Key Competencies

B-6.02.01	select and use repair tools and equipment such as feeler gauge, oil pressure gauge and measuring tools
B-6.02.02	remove, disassemble and inspect lubrication system components for conditions such as damage and wear
B-6.02.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications

B-6.02.04	replace, recondition or service components according to manufacturers' procedures and specifications
B-6.02.05	reassemble lubrication system components and perform measurements
B-6.02.06	identify and select specified lubricants
B-6.02.07	perform maintenance procedures such as changing oil and filter
B-6.02.08	perform priming and prelubrication of oil pressure system
B-6.02.09	complete repair by verifying system's function and performance

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Sub-task

B-6.03 Repairs cooling systems.

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

Key Competencies

B-6.03.01	select and use repair tools and equipment such as fin comb, seal installers and hand tools
B-6.03.02	remove, disassemble and inspect cooling system components for conditions such as damage and wear
B-6.03.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
B-6.03.04	repair or replace cooling system components such as radiators, hoses, gaskets, thermostats and water pumps
B-6.03.05	distinguish types and characteristics of coolants in order to avoid mixing incompatible types and to ensure required concentrations
B-6.03.06	drain, flush, refill and bleed coolant system
B-6.03.07	reassemble coolant system components
B-6.03.08	complete repair by verifying system's function and performance

Sub-task

B-6.04 Repairs intake and exhaust systems.

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

Key Competencies

B-6.04.01	select and use tools and equipment such as hand tools and pressure testing devices
B-6.04.02	remove, disassemble and inspect intake and exhaust system components for conditions such as damage and wear
B-6.04.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
B-6.04.04	repair, replace or recondition intake and exhaust system components such as manifolds, mufflers and coolers
B-6.04.05	reassemble intake and exhaust system components
B-6.04.06	repair, lubricate and prime turbo/super chargers
B-6.04.07	maintain intake system by servicing pre-cleaners and air filters
B-6.04.08	complete repair by verifying system's function and performance

Sub-task

B-6.05 Repairs fuel systems.

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

Key Competencies

B-6.05.01	select and use repair tools and equipment such as fuel pressure gauge, hand tools, and fuel transfer and storage equipment
B-6.05.02	remove, disassemble and inspect fuel system components such as fuel lines and manifolds for conditions such as damage and wear
B-6.05.03	select repair parts and materials such as gaskets, sealants, o-rings and fastening devices according to repair requirements and manufacturers' specifications
B-6.05.04	clean and repair or replace fuel system components such as fuel filters, governors pumps, common rail fuel components and injectors
B-6.05.05	reassemble fuel system components and perform measurements
B-6.05.06	torque components according to sequence and specifications

B-6.05.07	pressurize and bleed system
B-6.05.08	perform fuel system timing procedures
B-6.05.09	complete repair by verifying system's function and performance

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Sub-task

B-6.06 Repairs engine control systems.

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

Key Competencies

B-6.06.01	select and use repair tools and equipment such as hand tools and diagnostic tools
B-6.06.02	remove, disassemble and inspect mechanical engine control system components for conditions such as damage and wear
B-6.06.03	replace and calibrate electronic control components such as sensors and inectors according to manufacturers' specifications and government regulations
B-6.06.04	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
B-6.06.05	repair or replace engine control system components such as ECM, actuators, coils, plugs and mechanical linkages
B-6.06.06	reassemble engine control system components and calibrate
B-6.06.07	torque components according to sequence and specifications
B-6.06.08	complete repair by verifying system's function and performance
B-6.06.09	perform starting aid repairs such as glow plug, intake heater, block heater or ether injection

Sub-task

B-6.07 Repairs emission control systems.

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

Key Competencies

B-6.07.01	select and use diagnostic tools and equipment such as scan tool and exhaust gas analysers
B-6.07.02	remove, disassemble and inspect emission control system components for conditions such as damage and wear
B-6.07.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
B-6.07.04	repair or replace emission system components such as heaters, injectors, sensors, EGR valves, PVC and DPF filters
B-6.07.05	reassemble emission system components and calibrate
B-6.07.06	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

BLOCK C HYDRAULIC, HYDROSTATIC AND PNEUMATIC SYSTEMS

Context	Heavy duty equipment technicians' work on hydraulic, hydrostatic and pneumatic systems includes maintenance, diagnostic and mechanical repairs of system components and accessories. All diagnostic and repair tasks must be performed according to manufacturers' specifications.
Trends	There are higher pressures in these systems which reduce the overall weight and size of machines. Smaller components are being used to reduce dimensions. Electronic controls of these systems increase efficiency, comfort and remote operation. There have been improvements in filtration systems. Lubricants in these systems are more environmentally friendly. Alternate materials such as high-velocity oxygen fuel (HVOF) are being used to replace chrome hardening. Material quality has improved for more precise manufacturing.
Related Components (include, but not limited to)	Pumps, lines, valves, motors, hoses, cylinders, fittings, compressors, oil, compressed air, reservoirs, air dryers, controls, rotary joints, governors, electronic controls, air filters, accumulators.
Tools and Equipment	See Appendix A.

Task 7 Diagnoses hydraulic, hydrostatic and pneumatic systems.

Required Knowledge

K 1	fluids and fluid conditioning systems such as filtering systems, heating and cooling exchangers, and tanks
K 2	reference material such as schematic diagrams and service manuals
K 3	specified system performance
K 4	hydraulic system types, operation, components and specifications

K 5	hydrostatic system types, operation, components and specifications
K 6	pneumatic system types, operation, components and specifications
K 7	safe work procedures
K 8	depressurization of hydraulic tanks and pneumatic systems
K 9	electro-hydraulic operation, components and testing

Sub-task

C-7.01 Diagnoses hydraulic systems.

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

Key Competencies

C-7.01.01	select and use on-board diagnostic tools such as pressure gauges, flow meters and sight glass
C-7.01.02	locate components and perform tests such as cycle time, cylinder drift, pressure and flow test
C-7.01.03	perform visual and auditory inspection to identify problems such as leaks, cavitations and aeration
C-7.01.04	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
C-7.01.05	take fluid samples and interpret results to identify problems and trends
C-7.01.06	remove and disassemble component to identify problem
C-7.01.07	recognize worn, damaged and defective components such as motors, pumps, accumulators and control valves
C-7.01.08	take measurements of the hydraulic system components and compare to manufacturers' specifications
C-7.01.09	depressurize and repressurize hydraulic system according to manufacturers' specifications
C-7.01.10	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

C-7.02 Diagnoses hydrostatic systems.

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

Key Competencies

C-7.02.01	select and use diagnostic tools such as laptops, pressure gauges, flow meters and fluid level device
C-7.02.02	locate components and perform tests such as cycle time, case drain, pressure and flow test
C-7.02.03	perform visual and auditory inspection to identify problems such as leaks, cavitations and aeration
C-7.02.04	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
C-7.02.05	take fluid samples and interpret results to identify problems and trends
C-7.02.06	remove and disassemble component to identify problem
C-7.02.07	recognize worn, damaged and defective components such as motors, pumps and control valves
C-7.02.08	take measurements of the hydrostatic system components and compare to manufacturers' specifications
C-7.02.09	depressurize and repressurize hydrostatic system according to manufacturers' specifications
C-7.02.10	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

C-7.03 Diagnoses pneumatic systems.

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

Key Competencies

C-7.03.01	select and use diagnostic tools such as pressure gauges and multimeter
C-7.03.02	locate components and perform tests such as cycle time, pressure and leak test
C-7.03.03	perform visual and auditory inspection to identify problems such as leaks, contamination and heat

C-7.03.04	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
C-7.03.05	remove and disassemble component to identify problem
C-7.03.06	recognize worn, damaged and defective components such as compressors, air motors and control valves
C-7.03.07	take measurements of the pneumatic system components and compare to manufacturers' specifications
C-7.03.08	depressurize and repressurize pneumatic system according to manufacturers' specifications
C-7.03.09	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Task 8 Repairs hydraulic, hydrostatic and pneumatic systems.

Required Knowledge

K 1	fluids and fluid conditioning systems such as filtering systems, heating and cooling exchangers, and reservoirs
K 2	reference material such as schematic diagrams and service manuals
K 3	specified system performance
K 4	hydraulic system types, operation, components and specifications
K 5	hydrostatic system types, operation, components and specifications
K 6	pneumatic system types, operation, components and specifications
K 7	safe work procedures
K 8	depressurization of hydraulic tanks, air tanks and accumulators
K 9	bleeding procedures and methods to prevent air ignition in cylinders (dieseling)
K 10	electro-hydraulic operation, components and repair

Sub-task

C-8.01 Repairs hydraulic systems.

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

Key Competencies

C-8.01.01	select and use repair tools and equipment such as hand tools and shop tools
C-8.01.02	remove, disassemble and inspect hydraulic system components for conditions such as scoring, wear patterns and heat discolouration
C-8.01.03	flush hydraulic system as required according to manufacturers' specifications
C-8.01.04	inspect and service accumulators
C-8.01.05	select repair parts and materials such as motors, pumps and cylinders according to repair requirements and manufacturers' specifications
C-8.01.06	depressurize hydraulic system as per manufacturers' specifications and government regulations
C-8.01.07	remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
C-8.01.08	reassemble hydraulic system components and perform measurements
C-8.01.09	torque components according to sequence and specifications
C-8.01.10	assemble and install components according to manufacturers' specifications and procedures
C-8.01.11	adjust and calibrate hydraulic system components and parts to manufacturers' specifications
C-8.01.12	perform pre-lubrication, bleeding and priming procedures
C-8.01.13	perform start-up and break-in according to manufacturers' specifications and procedures
C-8.01.14	complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

Sub-task

C-8.02 Repairs hydrostatic systems.

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

Key Competencies

C-8.02.01	select and use repair tools and equipment such as hand tools, shop tools and laptop
C-8.02.02	remove, disassemble and inspect hydrostatic system components for conditions such as scoring, wear patterns and heat discolouration
C-8.02.03	flush hydrostatic system as required
C-8.02.04	select repair parts and materials such as motors, pumps and valves according to repair requirements and manufacturers' specifications
C-8.02.05	depressurize hydrostatic system as per manufacturers' specifications and government regulations
C-8.02.06	remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
C-8.02.07	reassemble hydrostatic system components and perform measurements
C-8.02.08	torque components according to sequence and specifications
C-8.02.09	assemble and install components according to manufacturers' specifications and procedures
C-8.02.10	adjust and calibrate hydrostatic system components and parts according to manufacturers' specifications
C-8.02.11	perform pre-lubrication, bleeding and priming procedures
C-8.02.12	perform start-up and break-in according to manufacturers' specifications and procedures
C-8.02.13	complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

Sub-task

C-8.03 Repairs pneumatic systems.

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

Key Competencies

C-8.03.01	select and use repair tools and equipment such as hand tools and shop tools
C-8.03.02	remove, disassemble and inspect pneumatic system components for conditions such as scoring, wear patterns and heat discolouration
C-8.03.03	select repair parts and materials such as motors, compressor and valves according to repair requirements and manufacturers' specifications
C-8.03.04	depressurize pneumatic system as per manufacturers' specifications and government regulations
C-8.03.05	remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
C-8.03.06	reassemble pneumatic system components and perform measurements
C-8.03.07	torque components according to sequence and specifications
C-8.03.08	assemble and install components according to manufacturers' specifications and procedures
C-8.03.09	adjust and calibrate pneumatic system components and parts to manufacturers' specifications
C-8.03.10	perform pre-lubrication
C-8.03.11	perform start-up and break-in according to manufacturers' specifications and procedures
C-8.03.12	complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

BLOCK D DRIVETRAIN SYSTEMS

Context

Heavy duty equipment technicians must be able to efficiently diagnose and repair drivetrain systems and sub-systems to maintain equipment performance and reliability to reduce equipment down time.

All diagnostic and repair tasks must be performed according to manufacturers' specifications.

Trends

Drivetrain systems and supporting systems are becoming more sophisticated and complex due to emission requirements and to lower maintenance costs. Electronics are prevalent throughout drivetrains and supporting systems, and technicians increasingly need a high level of computer skills and electronic diagnostic abilities.

Due to environmental concerns, manufacturers are moving towards the use of improved or new technologies such as hybrid drive systems, constantly variable transmission (CVT), electronic controlled transmission (ECT) systems, electric drives and improved filtration.

Related Components (include, but not limited to)

Clutch systems: flywheels, pressure plates, friction discs and plates, springs, forks, master cylinders, slave cylinders, bearings, seals, gaskets, fluids, filters, breathers, component control systems.

Torque converters, fluid couplers and retarders: stator, impellor, turbine, over running clutch, lockup-clutch, valves, pump, lines, coolers, seals, gaskets, bearings, fluids, filters, breathers.

Driveline systems: bearings, seals, gaskets, u-joints, yokes, slip joints, CV joints, drive shafts, lubricants.

Transmission and transfer case systems: clutch pack, piston, gears, gear sets, shafts, pump, bearings, seals, gaskets, fluids, filters, valves, lines, component control systems, cooler, breathers, planetary systems.

Axle and differential systems: axle, shafts, crown and pinion sets, spider gears, sun gears, limited slip and differential lockups, fluids, filters, coolers, lines, bearings, seals, gaskets, pump, component control systems, breathers.

Final drives: bearings, gears, seals, gaskets, shafts, fluids, filters, breathers, covers, planetary systems.

Tools and Equipment

See Appendix A.

Task 9 Diagnoses drivetrain systems.

Required Knowledge

K 1	reference material such as schematic diagrams and service manuals
K 2	clutch system types, operation, components and specifications
K 3	types of torque converters, fluid couplers and retarders, their operation, components and specifications
K 4	driveline system types, operation, components and specifications
K 5	transmission and transfer case system types, operation, components and specifications
K 6	axle and differential system types, operation, components and specifications
K 7	final drive system types, operation, components and specifications
K 8	specified system performance
K 9	types, viscosity and quality of fluids

Sub-task

D-9.01 Diagnoses clutch systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	NV	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.01.01	select and use diagnostics tools such as spring gauge, feeler gauge and dial indicator
D-9.01.02	identify types of clutch system and their operation
D-9.01.03	identify types of clutch controls such as manual, hydraulic, pneumatic and electric
D-9.01.04	perform sensory inspections to identify symptoms such as leaks, damaged components and odours
D-9.01.05	check fluid level and condition, and inspect for internal leaks or adjustment
D-9.01.06	perform functional tests to identify clutch slippage, vibrations or engagement
D-9.01.07	remove and disassemble components to identify problem
D-9.01.08	inspect clutch components in accordance with manufacturers' specifications and inspection procedures
D-9.01.09	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

D-9.02 Diagnoses torque converters, fluid couplers and retarders.

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

Key Competencies

D-9.02.01	select and use diagnostics tools such as pressure gauge, temperature gauge and flow meter
D-9.02.02	identify types of torque converters, fluid couplers, retarders and their operation
D-9.02.03	perform visual auditory inspections to identify symptoms such as leaks, excessive heat, odour and abnormal noise
D-9.02.04	check fluid level and condition
D-9.02.05	perform tests such as converter stall speed and pressure tests to identify internal leakage, vibration and engagement
D-9.02.06	remove and disassemble components to identify problem
D-9.02.07	inspect torque converters, fluid couplers and retarders in accordance with manufacturers' specifications and inspection procedures
D-9.02.08	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

D-9.03 Diagnoses driveline systems.

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

Key Competencies

D-9.03.01	select and use diagnostic tools such as dial indicator, angle gauge and straight edge
D-9.03.02	identify types of driveline systems and their operation
D-9.03.03	perform sensory inspections to identify symptoms such as vibration, abnormal noise and excessive heat
D-9.03.04	remove and disassemble components to identify problem
D-9.03.05	inspect components for wear, damage and defects

D-9.03.06 perform functionality tests according to manufacturers' specifications

D-9.03.07 interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

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Sub-task

D-9.04 Diagnoses transmission and transfer case systems.

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

Key Competencies

D-9.04.01 select and use diagnostic tools such as pressure gauge, computer and multimeter

D-9.04.02 identify types of transmission and transfer case systems such as manual, automatic, power shift and direct drive and their operation

D-9.04.03 check fluid level and condition

D-9.04.04 perform visual and auditory inspections to identify symptoms such as vibration, abnormal noise, leaks and excessive heat

D-9.04.05 remove and disassemble components to identify problem

D-9.04.06 perform diagnostic and functional tests according to manufacturers' specifications and procedures

D-9.04.07 interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

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Sub-task

D-9.05 Diagnoses axle and differential systems.

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

Key Competencies

D-9.05.01 select and use diagnostic tools such as temperature gauge and dial indicator

D-9.05.02 identify types of axle and differential systems and their operation

D-9.05.03 check fluid level and condition

D-9.05.04 perform sensory inspections to identify symptoms such as external leaks, abnormal noise and excessive heat

D-9.05.05 remove and disassemble components to identify problem

D-9.05.06	inspect axle and differential components in accordance with manufacturers' specifications and inspection procedures
D-9.05.07	perform diagnostic and functional tests according to manufacturers' specifications
D-9.05.08	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

D-9.06 Diagnoses final drive systems.

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

Key Competencies

D-9.06.01	select and use diagnostic tools such as temperature gauge and dial indicator
D-9.06.02	identify types of final drive systems and their operation
D-9.06.03	check fluid level and condition
D-9.06.04	perform visual and auditory inspections to identify symptoms such as leaks, noise and excessive heat
D-9.06.05	remove and disassemble components to identify problem
D-9.06.06	perform diagnostic and functional tests according to manufacturers' specifications
D-9.06.07	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Task 10 Repairs drivetrain systems.

Required Knowledge

K 1	clutch system types, operation, components and specifications
K 2	reference material such as schematic diagrams and service manuals
K 3	types of torque converters, fluid couplers and retarders, their operation, components and specifications
K 4	driveline system types, operation, components and specifications
K 5	transmission and transfer case system types, operation, components and specifications
K 6	axle and differential system types, operation, components and specifications

K 7	final drive system types, operation, components and specifications
K 8	specified system performance
K 9	types, viscosity and quality of fluids
K 10	manufacturers' specifications

Sub-task

D-10.01 Repairs clutch systems.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	NV	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-10.01.01	select and use repair tools and equipment such as pullers, dial indicator and alignment tools
D-10.01.02	remove, disassemble and inspect clutch system components for conditions such as damage and wear
D-10.01.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
D-10.01.04	replace, recondition or service components according to manufacturers' procedures and specifications
D-10.01.05	reassemble clutch system components and perform adjustments
D-10.01.06	perform bleeding procedures
D-10.01.07	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

Sub-task

D-10.02 Repairs torque converters, fluid couplers and retarders.

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

Key Competencies

D-10.02.01	select and use repair tools and equipment such as micrometer, feeler gauge and pullers
D-10.02.02	remove, disassemble and inspect torque converter, fluid coupler and retarder components for conditions such as damage and wear
D-10.02.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
D-10.02.04	replace, recondition or service components according to manufacturers' procedures and specifications
D-10.02.05	reassemble torque converter, fluid coupler and retarder components and perform adjustments
D-10.02.06	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

Sub-task

D-10.03 Repairs driveline systems.

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

Key Competencies

D-10.03.01	select and use repair tools and equipment such as pullers, torque wrench and press
D-10.03.02	remove, disassemble and inspect driveline system components for conditions such as damage and wear
D-10.03.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
D-10.03.04	replace, recondition or service components according to manufacturers' procedures and specifications

D-10.03.05 reassemble driveline components and perform adjustments

D-10.03.06 complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

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Sub-task

D-10.04 Repairs transmission and transfer case systems.

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

Key Competencies

D-10.04.01 select and use repair tools and equipment such as pullers, torque wrench and press

D-10.04.02 remove, disassemble and inspect transmission and transfer case system components for conditions such as damage and wear

D-10.04.03 select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications

D-10.04.04 replace, recondition or service components according to manufacturers' procedures and specifications

D-10.04.05 reassemble transmission and transfer case components and perform calibration and adjustments

D-10.04.06 complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

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Sub-task

D-10.05 Repairs axle and differential systems.

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

Key Competencies

D-10.05.01 select and use repair tools and equipment such as pullers, torque wrench and press

D-10.05.02 remove, disassemble and inspect axle and differential system components for conditions such as damage and wear

D-10.05.03 select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications

D-10.05.04	replace, recondition or service axle and differential components according to manufacturers' procedures and specifications
D-10.05.05	reassemble components and perform adjustments
D-10.05.06	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

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Sub-task

D-10.06 Repairs final drive systems.

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

Key Competencies

D-10.06.01	select and use repair tools and equipment such as pullers, induction heater and press
D-10.06.02	remove, disassemble and inspect final drive system components for conditions such as damage and wear
D-10.06.03	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
D-10.06.04	replace, recondition or service final drive components according to manufacturers' procedures and specifications
D-10.06.05	reassemble components and perform adjustments
D-10.06.06	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

BLOCK E STEERING, SUSPENSION, BRAKE SYSTEMS, WHEEL ASSEMBLIES AND UNDERCARRIAGE

Context

Heavy duty equipment technicians must be able to efficiently diagnose and repair steering, suspension and brake systems. These systems are integral to supporting and controlling the equipment safely.

It is important that all diagnostic and repair tasks are performed according to manufacturers' specifications and jurisdictional regulations. These components are vital to the safe operation of the equipment. There are specific safety concerns and hazards involved in working on these systems due to highly pressurized components.

Trends

There is a trend to higher standards in the safety aspect of these systems. With this, there are more electronic checks which warn of components' limitations and wear (for example, tire pressure monitoring systems).

Electronic controls are becoming more prevalent to help reduce operator fatigue. In brake systems, these are used in traction control systems. There are also more electronically-controlled steering features such as auto-centering and joystick steering, and suspension features such as load levelling and load sensing devices.

Tire installation is getting more specialized and is often out sourced to tire shops.

Related Components (include, but not limited to)

Wheel steering systems: tires, wheels, hubs, axles, spindles, king pins, pins, bushings, hydraulic pumps, control valves, cylinders, pumps, tie-rods, ball studs, steering wheel, joystick, pitman arm, drag links, steering shaft, hydraulic motor, wheel bearings, seals, fluids and lubricants, hoses and fittings, steering box, mounting hardware, electrical/electronic controls , secondary/emergency steering.

Track steering systems: control levers, linkages, control valves, steering clutches, steering brakes, hydraulic pump, hydraulic motor, lines, fluids and lubricants, sprockets, planetary system, electrical/electronic controls.

Suspension systems: spring hangers, springs, axle assemblies, pins, bushings, walking beams, hydro-pneumatic struts, torque rods, rubber blocks, air bags, air valves, shocks, struts, valves, accumulators, cylinders, fluids and lubricants, bolts, rivets, electrical/electronic controls.

Wet/dry brake systems: lines, hoses, booster, accumulators, valves, air supply system, air control system, brake actuator and linkage, pistons, drums, calipers, wheel cylinders, slack adjusters, s-cams, rotors, discs, plates, backing plates, shoes, springs, shafts, brake bands, anti-lock systems.

Wheel assemblies: tires, rims, tubes, wheels, mounting hardware, valve stems, automatic inflation systems, chains, seals, tire pressure sensors.

Undercarriage: tracks, frame, rollers, bogies, idlers, sprockets, pins, bushings, mounting hardware, guards, adjusting mechanism, equalizer bar, pivot shaft, recoil spring, related fasteners.

Tools and Equipment

See Appendix A.

Task 11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage.

Required Knowledge

K 1	jurisdictional regulations
K 2	steering system types and operation such as hydrostatic, hydraulic, clutch/brake and electric over hydraulic
K 3	steering system components and specifications
K 4	suspension system types, operation, components and specifications
K 5	wheel mounting types such as pilot-mount and hub-mount
K 6	wheel types such as steel, aluminium and composite
K 7	wear limits and patterns, and measurement methodology
K 8	tire construction such as radial, bias ply, steel and solid
K 9	tire inflation and ballast methods such as calcium, nitrogen and air
K 10	tire removal and installation, and general tire safety
K 11	the effects of related systems on wheel assemblies such as steering, suspension and brake systems
K 12	types and installation of tire chains

K 13	undercarriage system types, operation, components and specifications
K 14	tire pressure monitoring systems including pressure and temperature sensors

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Sub-task

E-11.01 Diagnoses steering systems.

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

Key Competencies

E-11.01.01	select and use diagnostic tools such as flow gauges, pressure gauges, multimeter, handheld scanner and onboard diagnostic
E-11.01.02	locate components and perform tests such as flow tests, pressure checks, cylinder leakage tests, motor leakage tests, cycle time tests and secondary steering tests
E-11.01.03	perform visual and auditory inspection to identify problems such as leaks, low tire pressure, uneven track tension, irregular tire or track wear patterns and worn, bent or broken parts
E-11.01.04	take fluid samples and interpret results to identify problems and trends
E-11.01.05	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
E-11.01.06	remove and disassemble defective component to identify problem
E-11.01.07	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

E-11.02 Diagnoses suspension systems.

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

Key Competencies

E-11.02.01	select and use diagnostic tools such as flow gauges, pressure gauges, pry bars and multimeters
E-11.02.02	locate components and perform tests such as pressure tests, leak tests and ride height test
E-11.02.03	perform sensory inspection to identify problems such as wear, leakage, cracks, sags, noise and vibration
E-11.02.04	take fluid samples and interpret results to identify problems and trends
E-11.02.05	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
E-11.02.06	remove and disassemble defective component to identify problem
E-11.02.07	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

E-11.03 Diagnoses brake systems.

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

Key Competencies

E-11.03.01	select and use diagnostic tools such as onboard computers, laptops, handheld scanners, pressure gauges, multimeters and infrared temperature gun
E-11.03.02	locate components and perform tests such as leak test, pressure test and stopping distance test
E-11.03.03	perform visual and auditory inspection to identify problems such as improper brake adjustment, contamination and leaks
E-11.03.04	take fluid samples and interpret results to identify problems and trends
E-11.03.05	compare equipment operation to manufacturers' specifications to verify complaint and expected performance

E-11.03.06 remove and disassemble defective component to identify problem

E-11.03.07 interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

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Sub-task

E-11.04 Diagnoses wheel assemblies.

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

Key Competencies

E-11.04.01 select and use diagnostic tools such as tread wear gauge, torque wrench, tire pressure gauge, tire monitoring sensors and onboard diagnostic

E-11.04.02 locate components and perform tests such as tire pressure test and wheel nut torque check

E-11.04.03 perform sensory inspection to identify problems such as leaks, cracks and worn components

E-11.04.04 verify that components meet manufacturers' specifications for the equipment

E-11.04.05 remove and disassemble defective component to identify problem

E-11.04.06 interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

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Sub-task

E-11.05 Diagnoses undercarriage systems.

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

Key Competencies

E-11.05.01 select and use diagnostic tools such as infrared temperature gun, calipers and ultrasonic tester

E-11.05.02 locate components and perform tests such as measuring pin wear, bushing wear and track pad wear

E-11.05.03 perform sensory inspection to identify problems such as wear, cuts, cracks and leaks

E-11.05.04 compare equipment operation to manufacturers' specifications to verify complaint and expected performance

E-11.05.05	remove and disassemble defective component to identify problem
E-11.05.06	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Task 12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage.

Required Knowledge

K 1	jurisdictional regulations
K 2	steering system types and operation such as hydrostatic, hydraulic, clutch/brake and electric over hydraulic
K 3	steering system components and specifications
K 4	suspension system types, operation, components and specifications
K 5	wheel mounting types such as pilot-mount and hub-mount
K 6	wheel types such as steel, aluminium and composite
K 7	wear limits and patterns, and measurement methodology
K 8	tire construction such as radial, bias ply, steel and solid
K 9	tire inflation methods such as calcium, nitrogen and air
K 10	tire removal and installation, and general tire safety
K 11	the effects of related systems on wheel assemblies such as steering, suspension and brake systems
K 12	types and installation of tire chains
K 13	undercarriage system types, operation, components and specifications

Sub-task

E-12.01 Repairs steering systems.

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

Key Competencies

E-12.01.01	select and use repair tools and equipment such as precision measuring tools, multimeter, hand tools and shop tools
E-12.01.02	depressurize steering systems as per manufacturers' specifications and government regulations
E-12.01.03	remove and disassemble defective and worn components according to manufacturers' specifications and procedures
E-12.01.04	select repair parts and materials according to repair requirements and manufacturers' specifications
E-12.01.05	assemble and install components according to manufacturers' specifications and procedures
E-12.01.06	replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
E-12.01.07	adjust and calibrate steering system components and parts to manufacturers' specifications
E-12.01.08	perform pre-lubrication and bleeding procedures
E-12.01.09	complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

Sub-task

E-12.02 Repairs suspension systems.

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

Key Competencies

E-12.02.01	select and use repair tools and equipment such as hand tools, power tools and shop tools
E-12.02.02	depressurize steering systems according to manufacturers' specifications and government regulations
E-12.02.03	remove and disassemble defective and worn components according to manufacturers' specifications and procedures

E-12.02.04	select repair parts and materials according to repair requirements and manufacturers' specifications
E-12.02.05	assemble and install components according to manufacturers' specifications and procedures
E-12.02.06	replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
E-12.02.07	adjust and calibrate suspension system components and parts to manufacturers' specifications
E-12.02.08	perform pre-lubrication, air build-up and charging procedures
E-12.02.09	complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

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Sub-task

E-12.03 Repairs brake systems.

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

Key Competencies

E-12.03.01	select and use repair tools and equipment such as hand tools, power tools and shop tools
E-12.03.02	depressurize suspension system as per manufacturers' specifications and government regulations
E-12.03.03	remove and disassemble defective and worn components according to manufacturers' specifications and procedures
E-12.03.04	select repair parts and materials according to repair requirements and manufacturers' specifications
E-12.03.05	assemble and install components according to manufacturers' specifications and procedures
E-12.03.06	replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
E-12.03.07	adjust brake system components and parts to manufacturers' specifications
E-12.03.08	perform pre-lubrication, air build-up, break-in and bleeding procedures
E-12.03.09	complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

Sub-task

E-12.04 Repairs wheel assemblies.

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

Key Competencies

E-12.04.01	select and use repair tools and equipment such as hand tools, power tools and shop tools
E-12.04.02	depressurize wheel assemblies according to manufacturers' specifications and government regulations
E-12.04.03	remove and disassemble defective and worn components according to manufacturers' specifications and procedures
E-12.04.04	select repair parts and materials according to repair requirements and manufacturers' specifications
E-12.04.05	assemble and install components according to manufacturers' specifications and procedures
E-12.04.06	replace, service and reassemble components according to manufacturers' specifications and procedures
E-12.04.07	adjust tire pressure to manufacturers' specifications
E-12.04.08	perform pre-lubrication procedures on wheel bearings
E-12.04.09	complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

Sub-task

E-12.05 Repairs undercarriage systems.

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

Key Competencies

E-12.05.01	select and use repair tools and equipment such as pin presses, torches, sledge hammers and impact wrenches
E-12.05.02	depressurize undercarriage systems according to manufacturers' specifications and government regulations
E-12.05.03	remove and disassemble defective and worn components according to manufacturers' specifications and procedures

E-12.05.04	select repair parts and materials according to repair requirements and manufacturers' specifications
E-12.05.05	assemble and install components according to manufacturers' specifications and procedures
E-12.05.06	replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
E-12.05.07	adjust undercarriage components and parts to manufacturers' specifications
E-12.05.08	perform pre-lubrication and break-in procedures
E-12.05.09	complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

BLOCK F ELECTRICAL AND VEHICLE MANAGEMENT SYSTEMS

Context

Electrical and vehicle management systems are vital to the operation of the vehicle and must work together to provide feedback to and from the driver. They control the operation of various components throughout the vehicle.

Heavy duty equipment technicians must diagnose and repair electrical and electronic faults in order to return the vehicle to service promptly.

Electronics increases operation efficiency and driver ergonomics.

Electrical and vehicle management systems enable companies to manufacture more environmentally friendly equipment.

Trends

There is an increase in the use of ECMs to control more components. In the future, there will be more use of wireless communication systems. There is a trend towards the use of global positioning system (GPS). Increasingly, electronic systems are being used in vehicle stability systems, proximity awareness and anti-theft. The use of higher voltage hybrid systems will become more common.

Related Components (include, but not limited to)

Electrical: battery, alternator, starter, SP switches, insulators, cables, wires, lights, wire harness, gauges, solenoids, relays, diodes, capacitors, inverters, converters, switches, fuses, fuse panel, buzzers, alarms, senders and coils, and fluids.

Vehicle management systems: electronic control modules, senders, coils, electronic control valves, speed sensors, temperature sensors, pressure sensors, position sensor and software.

Tools and Equipment

See Appendix A.

Task 13 Diagnoses electrical systems.

Required Knowledge

K 1	types and operation of starting systems
K 2	types and operation of charging systems
K 3	battery systems and voltages such as 6, 12, 24, 36 and 48 volt

K 4	basic wiring principles, schematics and diagrams
K 5	electrical principles such as Ohm's law and electron theory
K 6	general electrical components such as fuses, ignition switches, relays, circuit breakers and inverters
K 7	wire characteristics such as gauge, insulation and terminations
K 8	types and operation of lighting systems and components such as incandescent, LED and high intensity discharge (HID)
K 9	types and operation of wiper systems, components and accessories
K 10	types and operation of audio and video systems
K 11	audio and video system components such as displays and speakers
K 12	service considerations such as temperature, location of components and accessories
K 13	types of electronic accessories such as remote controls, GPS and material management computers
K 14	types and operation of instrumentation systems such as gauges, speedometers and tachometers
K 15	types and operation of displays such as temperature, compasses and engine monitoring
K 16	safety systems such as warnings, interlocks and lighting
K 17	potential hazards such as electrostatic discharge (ESD), electrocution and burns
K 18	types of electrical systems such as multiplex and CAN-bus

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Sub-task

F-13.01 Diagnoses starting/charging systems and batteries.

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

Key Competencies

F-13.01.01	select and use diagnostic tools and equipment such as amperage/voltage/resistance (AVR) meter, multimeter and circuit tester
F-13.01.02	inspect components and accessories such as capacitors, breakers and switches for signs of wear, damage or failure
F-13.01.03	perform boosting, charging and load testing of battery and battery systems
F-13.01.04	perform and interpret hydrometer test
F-13.01.05	interpret and follow wiring schematics and diagrams

F-13.01.06	perform starting/charging system and battery tests such as AVR, voltage drop and parasitic draw
F-13.01.07	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

F-13.02 Diagnoses electrical components, motors and accessories.

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

Key Competencies

F-13.02.01	select and use diagnostic tools and equipment such as multimeter, scan tool and circuit tester
F-13.02.02	inspect components, motors and wires for signs of wear, damage or failure
F-13.02.03	inspect connectors and connections for conditions such as corrosion, poor contacts and damaged terminals
F-13.02.04	interpret and follow wiring schematics and diagrams
F-13.02.05	perform tests such as voltage drop and resistance check to pinpoint failure
F-13.02.06	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Task 14 Repairs electrical systems.

Required Knowledge

K 1	types and operation of starting systems
K 2	types and operation of charging systems
K 3	battery systems and voltages such as 6, 12, 24, 36 and 48 volt
K 4	basic wiring principles, schematics and diagrams
K 5	electrical principles such as Ohm's law and electron theory
K 6	general electrical components such as fuses, ignition switches, relays, circuit breakers and inverters
K 7	wire characteristics such as gauge and insulation
K 8	types and operation of lighting systems and components such as incandescent, LED and HID

K 9	types and operation of wiper systems, components and accessories
K 10	types and operation of audio and video systems
K 11	audio and video system components such as displays and speakers
K 12	service considerations such as temperature and location of components and accessories
K 13	types of electronic accessories such as remote controls, GPS and material management computers
K 14	types and operation of instrumentation systems such as gauges, speedometers and tachometers
K 15	types and operation of displays such as temperature, compasses and engine monitoring
K 16	safety systems such as warnings, interlocks and lighting

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Sub-task

F-14.01 Repairs starting/charging systems and batteries.

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

Key Competencies

F-14.01.01	select and use tools and equipment such as scan tool, hand tools, multimeter and specialized tools
F-14.01.02	select repair parts and materials such as lubricants and fastening devices according to repair requirements and manufacturers' specifications
F-14.01.03	perform boosting, charging and load testing of battery and battery systems
F-14.01.04	remove components to access defective parts such as alternators, starters and batteries
F-14.01.05	replace or repair components according to manufacturers' specifications and recommendations
F-14.01.06	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

Sub-task

F-14.02 Repairs electrical components, motors and accessories.

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

Key Competencies

F-14.02.01	select and use tools and equipment such as hand tools and soldering equipment
F-14.02.02	select repair parts and materials such as terminals, insulators and fastening devices according to repair requirements and manufacturers' specifications
F-14.02.03	remove components to access defective parts such as wiring harnesses, connectors, relays and fusible links
F-14.02.04	replace or repair components according to manufacturers' specifications and recommendations
F-14.02.05	repair wiring using methods such as splicing, terminal replacement, soldering and crimping
F-14.02.06	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

Task 15 Diagnoses electronic vehicle management systems.

Required Knowledge

K 1	diagnostic code types such as fault codes, error codes and events
K 2	types of manufacturer-specific networks and software
K 3	diagnostic code protocols and actions
K 4	types, operation and interrelationship of modules
K 5	types of sensors such as revolutions per minute (RPM), throttle position (TPS) and vehicle speed sensor (VSS)
K 6	relationship of various parameters
K 7	parameter definitions
K 8	network circuitry types
K 9	input and output modules
K 10	vehicle diagnostic communication systems
K 11	methods of software transfer

K 12	basic computer processes
K 13	sensor and accumulator operation, calibration and testing procedures

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Sub-task

F-15.01 Reads diagnostic trouble codes (DTCs).

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

Key Competencies

F-15.01.01	select and use diagnostic software and scan tool to read and erase codes in systems such as powertrain control module (PCM), transmission control module (TCM) and ECM
F-15.01.02	perform functional tests to find active and intermittent codes
F-15.01.03	refer to manufacturers' diagnostic sequence for code definition

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Sub-task

F-15.02 Monitors parameters.

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

Key Competencies

F-15.02.01	select and use scan tool to monitor parameters such as TPS, EGR and intake air temperature (IAT)
F-15.02.02	use diagnostic tools to monitor parameters
F-15.02.03	select and organize relevant parameters to compare results
F-15.02.04	record parameters (snapshots) for playback to aid with diagnosis

Sub-task

F-15.03 Interprets test results.

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

Key Competencies

F-15.03.01	interpret relative parameters to compare results with manufacturers' specifications
F-15.03.02	determine faulty circuitry and/or components
F-15.03.03	refer to recorded parameters to assist in diagnosis

Sub-task

F-15.04 Tests system circuitry and components.

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

Key Competencies

F-15.04.01	select and use tools such as multimeter, circuit tester and break-out box to diagnose circuitry and components such as wiring, sensors and modules according to manufacturers' specifications
F-15.04.02	determine faulty circuitry, sensors and components

Task 16 Repairs electronic vehicle management systems.

Required Knowledge

K 1	methods of software transfer
K 2	basic computer processes
K 3	types of components such as control module, wire harnesses, and input and output devices
K 4	cable types such as twisted pair and shielded wire
K 5	types of wiring repair procedures such as splicing, soldering and crimping

K 6	methods of verifying repair such as clear codes, retest and operational tests
K 7	sensor operation, testing, calibration and adjustment procedures

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Sub-task

F-16.01 Updates component software.

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

Key Competencies

F-16.01.01	select and use scan tool and diagnostic software to update module software
F-16.01.02	program modules using manufacturers' specifications and updated documentation such as service bulletins, service alerts and service software
F-16.01.03	configure modules according to vehicle requirements and options
F-16.01.04	verify operation of updated modules according to manufacturers' speicifications and government regulations

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Sub-task

F-16.02 Repairs components.

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

Key Competencies

F-16.02.01	select and use tools and equipment such as hand tools, scan tool and specialty tools
F-16.02.02	follow vehicle-specific cautionary procedures such as using anti-static straps and disabling power sources
F-16.02.03	transfer module-specific data to component
F-16.02.04	identify and install compatible electronic components according to the vehicle specifications
F-16.02.05	replace faulty circuitry, sensors and components
F-16.02.06	complete repair by verifying system's function and operation according to manufacturers' specifications and government regulations

BLOCK G ENVIRONMENTAL CONTROL SYSTEMS

Context

Environmental control systems include accessories and options for driver's comfort and safety. Diagnosis and repair have to be performed according to manufacturers' specifications and procedures. Incorrect processes can result in personal injury, health issues and environmental damage.

Operators are required to work longer hours in the cab which increase the importance of keeping their environment safe and comfortable.

Positive cabin pressure and filtered air are needed to keep the air cabin dust-free to protect the operator and sensitive electronic circuits.

Trends

There is an increased use of non-repairable electrical components and lighter weight materials. There are more consumer-controlled features and personalization of vehicles. New comfort features include instant cabin heat and cooled/heated seats.

Related Components (include, but not limited to)

Auto control systems (Heating Ventilation Air Conditioning (HVAC)): A/C compressor, hoses/fittings, condensers/evaporators, heater core, receiver/dryer, accumulator, controls, controller, sensors, filters, control valves, coolant/refrigeration fluids, fans/motors, vents.

Tools and Equipment

See Appendix A.

Task 17 Diagnoses environmental control systems.

Required Knowledge

K 1	diagnostic tools such as onboard computer, hand tools, air flow gauge and temperature gauge
K 2	heating system types, operation, components and specifications
K 3	ventilation system types, operation, components and specifications
K 4	filtration system types, operation, components and specifications
K 5	air conditioning system types, operation, components and specifications
K 6	types and operation of air flow control systems such as manual, electrical and electronic
K 7	operation of components such as fans, blend doors, levers and actuators

K 8	causes of odours
K 9	types and operation of refrigerant systems
K 10	principles of refrigeration
K 11	refrigerants, lubricants and consequences of improper mixing
K 12	electronic control systems
K 13	types and operation of heating systems
K 14	operation of components such as heater core, thermostats, coolant pumps and restrictors
K 15	coolant types and characteristics
K 16	cabin filters and their locations
K 17	legislation regarding licensing requirements, use, handling and disposal of refrigerants

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Sub-task

G-17.01 Diagnoses heating systems.

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

Key Competencies

G-17.01.01	select and use diagnostic tools such as thermometer, multimeter and vacuum gauge
G-17.01.02	locate components and perform tests such as coolant levels, air flow tests and temperature tests
G-17.01.03	perform sensory inspection to verify customer complaint such as noises, no heat, too much heat and odours to guide the diagnostic process
G-17.01.04	compare equipment operation to expected performance
G-17.01.05	recognize worn, damaged and defective components such as fans, hoses and motors
G-17.01.06	remove and disassemble component to identify problem
G-17.01.07	determine diagnostic sequence according to manufacturers' specifications
G-17.01.08	depressurize cooling system before removing radiator cap to avoid personal injury
G-17.01.09	identify faulty systems such as engine cooling system or HVAC
G-17.01.10	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

G-17.02 Diagnoses ventilation and filtration systems.

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

Key Competencies

G-17.02.01	select and use diagnostic tools and equipment such as multimeter, circuit tester and scan tool
G-17.02.02	locate components and perform tests such as air flow tests, voltage tests and resistance tests
G-17.02.03	perform sensory inspection to verify customer complaint such as noises and odours to guide the diagnostic process
G-17.02.04	compare equipment operation to expected performance
G-17.02.05	recognize worn, damaged and defective components such as filters, filter housings and fans
G-17.02.06	interpret and follow wiring diagrams and air flow schematics
G-17.02.07	interpret viewed values and codes to determine condition of systems, components and accessories
G-17.02.08	activate system self-diagnosis function to retrieve trouble codes
G-17.02.09	remove and disassemble component to identify problem
G-17.02.10	check electronically controlled system operation for conditions such as blown fuses, seized motors and broken wires
G-17.02.11	inspect air flow circulation to identify problems such as partially closed doors, restricted cabin filters and odours
G-17.02.12	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications or expected performance

Sub-task

G-17.03 Diagnoses air conditioning systems.

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

Key Competencies

G-17.03.01	select and use diagnostic tools and equipment such as multimeter, circuit tester, A/C gauges, A/C recovery/recycling unit and black lights
G-17.03.02	locate components and perform tests such as refrigerant pressure tests, air flow tests, voltage tests and resistance tests
G-17.03.03	perform visual and auditory inspection to verify customer complaint such as noises and odours to guide the diagnostic process
G-17.03.04	compare equipment operation to expected performance
G-17.03.05	recognize worn, damaged and defective components such as condensers, evaporators, hoses and seals
G-17.03.06	interpret and follow wiring diagrams and air flow schematics
G-17.03.07	interpret viewed values and codes to determine condition of systems, components and accessories
G-17.03.08	activate system self-diagnosis function to retrieve trouble codes
G-17.03.09	remove and disassemble components to identify problem
G-17.03.10	check electronically-controlled system operation for conditions such as blown fuses, seized motors and broken wires
G-17.03.11	identify compatibility of refrigerant with systems, tools and seals
G-17.03.12	pressurize systems with nitrogen to locate leaks according to manufacturers' specifications and government regulations
G-17.03.13	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications or expected performance

Sub-task

G-17.04 Diagnoses sound suppression systems.

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

Key Competencies

G-17.04.01	select and use diagnostic tools and equipment
G-17.04.02	perform sound level tests
G-17.04.03	perform sensory inspection to identify problems such as noise and vibration
G-17.04.04	recognize worn, damaged and defective components such as door and window seals, and loose fasteners
G-17.04.05	remove and disassemble components to identify problem
G-17.04.06	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
G-17.04.07	record sound levels to identify problems and trends
G-17.04.08	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications and regulations

Task 18 Repairs environmental control systems.

Required Knowledge

K 1	heating system components
K 2	ventilation system components
K 3	filtration system components
K 4	air conditioning system components
K 5	specified system performance
K 6	types and operation of air flow control systems
K 7	procedures to correct problems such as odours, air flow restrictions and noises
K 8	types and operation of refrigerant systems
K 9	refrigerant system hazards
K 10	types and operation of components such as compressors, clutches and receiver dryers
K 11	metering devices such as orifice tubes, expansion valves and coolant valves

K 12	types of refrigerants and oils
K 13	legislation regarding licensing requirements, use, handling and disposal of refrigerants
K 14	electronic control systems
K 15	types and operation of heating systems
K 16	types of coolants and chemical additives
K 17	water quality suitable for heating systems

Sub-task

G-18.01 Repairs heating systems.

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

Key Competencies

G-18.01.01	select and use tools and equipment such as hand tools, scan tools, coolant recovery unit and multimeter
G-18.01.02	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
G-18.01.03	remove, disassemble and inspect heating system components for conditions such as low heat and no air flow
G-18.01.04	follow repair sequence according to manufacturers' specifications
G-18.01.05	depressurize cooling system before removing radiator cap to avoid personal injury
G-18.01.06	fill and bleed cooling system
G-18.01.07	replace, recondition, service and reassemble components such as blend doors, hoses and control valves according to manufacturers' specifications and procedures
G-18.01.08	adjust heating system components and parts to manufacturers' specifications
G-18.01.09	reassemble heating system components and perform measurements
G-18.01.10	clean and deodorize air flow systems with materials such as compressed air, sanitizers and pressurized deodorizers
G-18.01.11	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

Sub-task

G-18.02 Repairs ventilation and filtration systems.

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

Key Competencies

G-18.02.01	select and use tools and equipment such as hand tools, scan tools and specialized tools
G-18.02.02	select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
G-18.02.03	remove, repair or replace faulty components such as control units, filters and blend doors
G-18.02.04	follow repair sequence according to manufacturers' specifications and expected performance
G-18.02.05	replace, recondition, service and reassemble components such as control units, filters and blend doors according to manufacturers' specifications and procedures
G-18.02.06	reassemble ventilation and filtration system components and perform measurements
G-18.02.07	clean and deodorize air flow systems with materials such as compressed air, sanitizers and pressurized deodorizers
G-18.02.08	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

Sub-task

G-18.03 Repairs air conditioning systems.

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

Key Competencies

G-18.03.01	select and use repair tools and equipment to evacuate and recharge system and to identify types of refrigerant
G-18.03.02	select repair parts and materials and follow repair sequence according to manufacturers' specifications and procedures
G-18.03.03	recover refrigerant and evacuate air conditioning system according to jurisdictional regulations

G-18.03.04	remove, repair and replace faulty components such as switches, hoses and expansion valves
G-18.03.05	follow repair sequence according to manufacturers' specifications and expected performance
G-18.03.06	reassemble air conditioning system components and perform measurements
G-18.03.07	recharge system to recommended amounts of refrigerant and oils according to manufacturers' specifications
G-18.03.08	clean and deodorize air flow systems with materials such as compressed air, sanitizers, pressurized deodorizers and cleaning agents
G-18.03.09	convert systems to run on other refrigerants according to manufacturers' requirements by performing tasks such as replacing fittings and changing refrigerant oil
G-18.03.10	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

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Sub-task

G-18.04 Repairs sound suppression systems.

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

Key Competencies

G-18.04.01	select and use repair tools and equipment such as scrapers, applicator gun and seal removers to repair panels, seals and insulation
G-18.04.02	select repair parts and materials and follow repair sequence according to manufacturers' specifications and procedures
G-18.04.03	remove, disassemble, recondition and replace faulty components such as matting, insulation and seals
G-18.04.04	reassemble sound suppression system components and perform measurements
G-18.04.05	complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

BLOCK H STRUCTURAL COMPONENTS, ACCESSORIES AND ATTACHMENTS

Context

The structural components are necessary to provide a safe working environment for the operator and others.

The accessories and attachments are vital to the productivity and diversity of the equipment. They must work together to be efficient.

Heavy duty equipment technicians must diagnose, repair and install structural components, accessories and attachments as per company's preference.

The accessories and attachments enable companies to manufacture more environmentally friendly equipment.

Trends

Manufacturers are building machines with the intent of having the versatility needed in the equipment industry. A broad range of attachments and accessories are offered to clients from manufacturers or aftermarket suppliers.

An increase in safety awareness created the need for the development of specific attachments and accessories such as guards, safety glass and machine lock-outs.

For productivity, there is an increase in electronic monitoring, controlled attachments and accessories such as GPS, load management devices, tree harvesters and lighting.

Productivity will dictate the future of structural components, accessories and attachments.

Inspection of structural components, especially ROPS, is being done by engineers for liability reasons.

Equipment features include more operator friendly controls and even full automated control such as joysticks, automated function sequences and automatic levelling controls.

Related Components (include, but not limited to)

Structural components: frames, ROPS/FOPS/OPS, guards, covers and belly pans, boom, sticks and loader arms, platform, stairs, rails, swing and articulation bearings.

Operator station: switches, handles, levers, pedals, gauges, power controls, padded walls/insulation/sound proofing, emergency exit system, sun visors, steering, seat, seat belt, bulbs, glass, wiper, windshield washer, door, radio, mirrors, GPS.

Attachments and accessories: manufacturers' or after-market attachments (buckets, hammer, forks, tree harvesters, clams and grapples), mounting hardware, hydraulic components (hoses, fittings, couplers, actuators, valves, electrical and electronic controls), ground engaging tools, manufacturers' or after-market accessories (auto greaser, light, anti-vandalism equipment, cold weather package, railings, platforms).

Tools and Equipment See Appendix A.

Task 19 Diagnoses structural components, accessories and attachments.

Required Knowledge

K 1	structural component construction
K 2	government and company regulations
K 3	operator station types, operation, regulations, components and specifications
K 4	attachment types, operation, regulations, components and specifications
K 5	accessory types, operation, regulations, components and specifications
K 6	interaction of components, accessories and attachments with existing systems
K 7	fundamentals of alignment using tools such as plumb bobs and laser levels

Sub-task

H-19.01 Diagnoses structural components.

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

Key Competencies

H-19.01.01	select and use diagnostic tools such as dial indicator and magnetic particle tester
H-19.01.02	locate components and perform tests such as dye check test, pin and bearing clearance test and magnetic particle test
H-19.01.03	perform sensory inspection to identify problems such as cracks, leaks and defects

H-19.01.04	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
H-19.01.05	remove and disassemble defective component to identify problem
H-19.01.06	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

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Sub-task

H-19.02 Diagnoses operator station components.

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

Key Competencies

H-19.02.01	select and use diagnostic tools such as decibel meter, diagnostic software and multimeter
H-19.02.02	locate components and perform operational tests of components, accessories and attachments
H-19.02.03	perform sensory inspection to identify problems such as cracks, leaks and defects
H-19.02.04	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
H-19.02.05	remove and disassemble defective component to identify problem
H-19.02.06	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Sub-task

H-19.03 Diagnoses attachments and accessories.

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

Key Competencies

H-19.03.01	select and use diagnostic tools such as flow meter, multimeter and diagnostic software
H-19.03.02	locate components and perform tests such as flow test, pressure test and circuit test
H-19.03.03	perform sensory inspection to identify problems such as cracks, leaks and defects
H-19.03.04	compare equipment operation to manufacturers' specifications to verify complaint and expected performance
H-19.03.05	remove and disassemble defective component to identify problem
H-19.03.06	interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

Task 20 Repairs structural components, accessories and attachments.

Required Knowledge

K 1	construction of structural components
K 2	operator station types, operation, regulations, components and specifications
K 3	attachment types, operation, regulations, components and specifications
K 4	accessory types, operation, regulations, components and specifications
K 5	company standards and regulations
K 6	equipment systems related to structural components, accessories and attachments
K 7	specified accessory performance
K 8	interaction of components, accessories and attachments with existing systems
K 9	government regulations such as Canadian Welding Bureau (CWB)
K 10	fundamentals of alignment using tools such as plumb bobs and laser levels

Sub-task

H-20.01 Performs mechanical repairs on structural components.

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

Key Competencies

H-20.01.01	select and use repair tools and equipment such as precision measuring tools, hand tools, shop tools and welding equipment
H-20.01.02	remove and disassemble defective and worn components according to manufacturers' specifications and procedures
H-20.01.03	select repair parts and materials according to repair requirements and manufacturers' specifications
H-20.01.04	assemble and install components according to manufacturers' specifications and procedures
H-20.01.05	replace, recondition, service and reassemble components such as frames, lift arms and booms according to manufacturers' specifications and procedures
H-20.01.06	perform adjustments on components such as bearings and booms to manufacturers' specifications
H-20.01.07	perform pre-lubrication procedures
H-20.01.08	complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

Sub-task

H-20.02 Repairs operator station components.

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

Key Competencies

H-20.02.01	select and use repair tools and equipment such as multimeter, hand tools, shop tools, oxyacetylene torches and welding equipment
H-20.02.02	remove and disassemble defective and worn components according to manufacturers' specifications and procedures
H-20.02.03	select repair parts and materials according to repair requirements and manufacturers' specifications
H-20.02.04	replace, recondition, service and reassemble components according to manufacturers' specifications and procedures

H-20.02.05	adjust operator station components such as controls and sensors to manufacturers' specifications
H-20.02.06	complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

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Sub-task

H-20.03 Repairs attachments and accessories.

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

Key Competencies

H-20.03.01	select and use repair tools and equipment such as precision measuring tools, hand tools, shop tools and welding equipment
H-20.03.02	remove and disassemble defective and worn components according to manufacturers' specifications and procedures
H-20.03.03	select repair parts and materials according to repair requirements and manufacturers' specifications
H-20.03.04	replace, recondition, service and reassemble components according to manufacturers' specifications and CWB welding procedures
H-20.03.05	adjust attachments and accessories such as buckets, forks and auto-greaser to manufacturers' specifications
H-20.03.06	perform pre-lubrication, bleeding and start-up procedures
H-20.03.07	complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

Sub-task

H-20.04 Installs attachments and accessories.

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

Key Competencies

H-20.04.01	select and use tools and equipment such as precision measuring tools, hand tools and shop tools
H-20.04.02	remove and disassemble components according to manufacturers' specifications and procedures for installation of attachments and accessories
H-20.04.03	select parts and materials according to installation requirements and manufacturers' specifications
H-20.04.04	assemble and install components according to manufacturers' specifications and procedures
H-20.04.05	adjust attachments and accessories such as clams, buckets and tree harvesters to manufacturers' specifications
H-20.04.06	complete installation by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

APPENDICES

APPENDIX A TOOLS AND EQUIPMENT

Basic Hand Tools

1/4, 3/8, 1/2, and 3/4 -inch drive socket sets
adjustable wrench
bar (pry, aligning, heel)
battery post and clamp cleaner, battery terminal nut
battery terminal puller
brass drift
center punch
chisel
convertible 2/3 jaw puller
cutting equipment: side cutter, tube cutter, wire cutter, plier cutters, shears
digital multimeter
feeler gauge set
file
H puller
hacksaw and blade
hammer: impact, rubber, sledge, air, slide, soft blow
hex key set, metric and imperial
impact wrench (up to 1/2-inch)
jumper wire
magnetic pick-up tool (telescopic, flex)
metric and imperial steel rule
micrometer
pick (o-ring, seal)
pin punch
pipe wrench
pliers: insulated, snap ring, torque, multipliers
punch
scraper
screwdriver
tape measure
test light
tool chest
torque wrench (pneumatic & hydraulic)
torx bit
universal joint
utility knife
vernier caliper
wire brush
wire crimper and stripper
wrench set, combination (metric & imperial)
wrench set, flare nut (metric & imperial)

Shop Tools

3/4 – 1 inch power bar/torque wrench
air compressor
air line adapter
alignment tool
analyzer: gas, infrared, vibration meter
battery charger
battery load/starting system tester
bearing heater
black light
bleeding equipment
booster cable
butane torch
caliper: outside, inside
carburetor tool
chemical agitator
chisel: air, electric, hand
clutch alignment tool
component heating or cooling equipment

Shop Tools (continued)

compressors: air, mechanical spring, piston ring, pneumatic spring, spring, valve spring
computer equipment: terminal, on-board computer, portable diagnostic computer, printer
connecting rod aligner
container
continuity tester
coolant recycling unit
cooling system pressure tester
crack detecting equipment
crimping tool
cutting and welding torch set
cylinder cart and tank
diagnostic equipment
drift
drill: bench, hand drivers, twist, air
exhaust expander
extension cord/trouble light
fast charger
file
flaring tool
flushing kit
fuel quality test kit
fuel recovery and storage system
funnel
graduated vessel
grease gun
grinder: bench, hand, valve
hand pump
harness tester
honing equipment
hot air gun
labelling kit
leak detection equipment
leakdown tester
level protractor
module tester
nitrogen charging equipment
overhaul tools
press: arbor, spring, hydraulic, bushing, shop, mechanical, hand
pry bar
puller: bearing, gear, heavy duty, mechanical
reamer
recycling unit
refractometer
retrieval and storage equipment
ridge reamer
sandblaster
sander
saw: jigsaw, hacksaw, hole saw
scanning tool
seal driver
shop vacuum
soldering iron/gun
spacer
spark lighter
steering tool
straight edge
strobe light
stud extractor
suction cups
tachometer
tap and die set
temperature gauge
thermostat tester
thread file
tire bar
tire machine
tire tread depth gauge
torque angle tool, torque wrench
torque multiplier
tube bender
vacuum pump
valve grinding equipment
valve guide service kit
valve lapping block
valve seat grinding equipment
valve spring tester
vice
welding equipment

Safety Equipment

apron
communication device
CPR accessories (disposable)
ear protection
emergency backup lighting
eye wash station
face shield
fall arrest equipment
fall prevention equipment
fire extinguisher
fireproof blanket
first aid station
gas mask
gloves
goggles
ladder
leather gloves
leggings
manlift
respirator
safety boots
safety cage
safety glasses
safety hat
splash suit
sprinkler system
stretcher

Hoisting, Rigging and Holding Equipment

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

Cleaning Equipment

air blowgun
brake cleaning equipment
caustic cleaning tank
cleaning cloth
cleaning gloves
crocus cloth
glass bead machine
hot tank degreaser
parts cleaning solvent
pressure washer
soft brush
solvent washer
steam cleaner
wire brush

Measuring Tools, Gauges and Equipment

air pressure gauge
pinion angle gauge

ammeter
belt tension gauge
boost gauge
borescope
compression gauge
cylinder bore gauge
depth micrometer
dial gauge
electric pressure gauge
flowmeter
fuel pressure gauge
holding gauge
hydraulic pressure testing gauge/fittings
hydrometer
inside micrometer
level
manifold gauge
measuring rod
mechanical pressure gauge
meter stick
non-magnetic feeler gauge
oil temperature gauge
phototachometer
plasti-gauge
pressure gauge
pull-type scale
pyrometer
small hole gauge
spectroscope
spring scale
steel ruler
stethoscope
straight edge
tachometer
telescoping gauge
test lead
test light
thermometer
timing gauge
timing light

tire gauge
torquemeter
transmission gauge set
vacuum gauge
vibration analyzer

APPENDIX B GLOSSARY

accessories non-essential components added to the machine to enhance the operation or extend machine longevity; for example: greasing systems, radio, air conditioning and extra lights. Although some accessories are non-essential to the machine operation, they are sometimes required in extreme operating environments

attachments components added to the machine that are integral to its operation to perform a specific job; for example: ripper, winch, thumb, hammer, tamper or forks

base engine assembled block and head including internal components and gear trains

break-in a controlled operation specified by the manufacturer on new or repaired components to maximize service life

cold weather package accessories used to aid machine start-up and operation in cold weather environments; may include fluid heaters, extra batteries, glow plug systems, ether injection systems, heating pads and inlet air heaters

driveline the shafts, bearings and joints located between a drive component and a driven component

drivetrain the mechanical portion of the driveline from the flywheel to the tires or the track excluding hydrostatic systems and electric motors

electrical systems starting, charging, lighting and accessory circuits without computer control modules

electronic systems electrical systems operated via computerized electronic control modules and related sensors and wiring

hydrostatic system a hydraulic system which uses fluid under pressure to transmit power through tubes or hoses to drive components such as wheel or track drives

operator station environment where the operator controls and monitors the equipment

overhaul rebuild or repair to like new condition

powertrain	includes the drivetrain plus the engine (including hydrostatic systems and electric motors), used to produce power and transmit that power to the drive components (wheels, tracks, legs, etc.)
sensory inspection	diagnosing or inspecting using sight, sound, smell and feel
start-up	a specific procedure to begin operation of a machine or system
structural components	components that make up the integral structure of the machine; for example: frame, lift arms, booms, sticks, loader frames, counterweights, ROPS, FOPS and OPS
suspension	components that support the main frame from the ground and may include undercarriage, axle and wheel assemblies
undercarriage	track type components required to support the machine and transmit power from the final drive to the ground
vehicle management system	interface between the operator and the equipment's other systems that enables operation and monitoring of the machine
wheel assembly	wheel or rim assembly, tire and attaching hardware

APPENDIX C ACRONYMS

AVR	amperage/voltage/resistance
BSP	British Standard Pipe
CAN	controller area network
CNG	compressed natural gas
CVIP	Commercial Vehicle Inspection Program
CVT	constantly variable transmission
DPF	diesel particulate filter
DTCs	diagnostic trouble codes
ECM	electronic control modules
ECT	electronic controlled transmission
EGR	exhaust gas recirculation
ESD	electrostatic discharge
FOPS	falling object protective structure
GPS	Global Positioning System
HID	high intensity discharge
HS	high-speed
HVAC	heating, ventilation and air conditioning
HVOF	high-velocity oxygen fuel
IAT	intake air temperature
JIC	Joint Industry Committee
LED	light emitting diode
LPG	liquefied propane gas

MIG	metal inert gas
MSDS	Material Safety Data Sheet
NVH	noises, vibrations and harshness
OPS	Operator protection structure
ORB	o-ring boss
ORF	o-ring flange
PCM	powertrain control module
PCV	positive crankcase ventilation
PCV	positive crankcase ventilation
ROPS	roll-over protective structure
RPM	revolutions per minute
SAE	Society of Automotive Engineers
SMAW	shielded metal arc welding
TCM	transmission control module
TDG	Transport of Dangerous Goods
TIG	tungsten inert gas
TPS	throttle position sensor
VIN	vehicle identification number
VSS	vehicle speed sensor
WHMIS	Workplace Hazardous Materials Information System

APPENDIX D BLOCK AND TASK WEIGHTING

BLOCK A COMMON OCCUPATIONAL SKILLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	5	10	8	5	NV	7	10	9	10	5	NV	NV	NV	8%

Task 1 Uses and maintains tools and equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	10	20	21	NV	33	30	27	20	20	NV	NV	NV	24%

Task 2 Performs general maintenance and inspections.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	40	30	30	NV	45	30	37	35	50	NV	NV	NV	36%

Task 3 Organizes work.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	30	20	19	NV	0	10	19	25	10	NV	NV	NV	17%

Task 4 Performs routine trade activities.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	20	30	30	NV	22	30	17	20	20	NV	NV	NV	23%

BLOCK B ENGINES AND ENGINE SUPPORT SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	15	15	20	NV	13	17	15	16	15	NV	NV	NV	16%

Task 5 Diagnoses engines and engine support systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	60	67	60	50	NV	70	55	65	55	60	NV	NV	NV	60%

Task 6 Repairs engines and engine support systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	33	40	50	NV	30	45	35	45	40	NV	NV	NV	40%

BLOCK C HYDRAULIC, HYDROSTATIC AND PNEUMATIC SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	20	18	20	NV	25	16	17	15	20	NV	NV	NV	19%

Task 7 Diagnoses hydraulic, hydrostatic and pneumatic systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	60	75	60	50	NV	80	60	63	60	60	NV	NV	NV	63%

Task 8 Repairs hydraulic, hydrostatic and pneumatic systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	25	40	50	NV	20	40	37	40	40	NV	NV	NV	37%

BLOCK D DRIVETRAIN SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	15	13	12	NV	12	15	16	15	20	NV	NV	NV	14%

Task 9 Diagnoses drivetrain systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	60	67	55	60	NV	80	55	60	45	50	NV	NV	NV	59%

Task 10 Repairs drivetrain systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	33	45	40	NV	20	45	40	55	50	NV	NV	NV	41%

BLOCK E STEERING, SUSPENSION, BRAKE SYSTEMS, WHEEL ASSEMBLIES AND UNDERCARRIAGE

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	15	10	18	13	NV	14	15	9	13	15	NV	NV	NV	14%

Task 11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	60	40	50	50	NV	80	60	53	50	60	NV	NV	NV	56%

Task 12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	60	50	50	NV	20	40	47	50	40	NV	NV	NV	44%

BLOCK F ELECTRICAL AND VEHICLE MANAGEMENT SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	20	15	20	NV	20	17	20	15	15	NV	NV	NV	18%

Task 13 Diagnoses electrical systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	45	30	30	NV	48	30	31	30	30	NV	NV	NV	34%

Task 14 Repairs electrical systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	30	20	20	NV	2	20	13	20	20	NV	NV	NV	18%

Task 15 Diagnoses electronic vehicle management systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	15	30	30	NV	48	30	43	30	30	NV	NV	NV	32%

Task 16 Repairs electronic vehicle management systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	10	20	20	NV	2	20	13	20	20	NV	NV	NV	16%

BLOCK G ENVIRONMENTAL CONTROL SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	5	7	6	5	NV	5	5	8	9	5	NV	NV	NV	6%

Task 17 Diagnoses environmental control systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	60	70	55	60	NV	80	55	60	50	60	NV	NV	NV	61%

Task 18 Repairs environmental control systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	30	45	40	NV	20	45	40	50	40	NV	NV	NV	39%

BLOCK H STRUCTURAL COMPONENTS, ACCESSORIES AND ATTACHMENTS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	5	3	7	5	NV	4	5	6	7	5	NV	NV	NV	5%

Task 19 Diagnoses structural components, accessories and attachments.

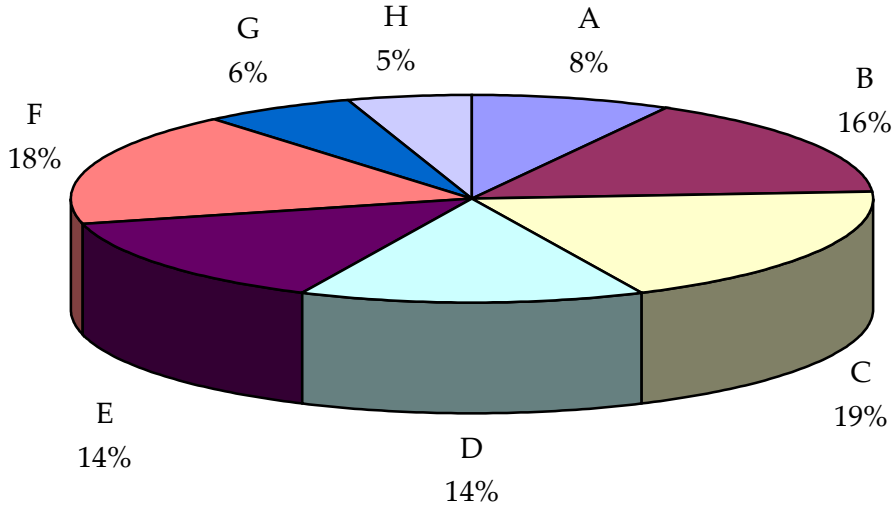
	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	60	33	50	51	NV	80	40	50	50	50	NV	NV	NV	52%

Task 20 Repairs structural components, accessories and attachments.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	40	67	50	49	NV	20	60	50	50	50	NV	NV	NV	48%

APPENDIX E

PIE CHART*



TITLES OF BLOCKS

BLOCK A	Common Occupational Skills	BLOCK E	Steering, Suspension, Brake Systems, Wheel Assemblies and Undercarriage
BLOCK B	Engines and Engine Support Systems	BLOCK F	Electrical and Vehicle Management Systems
BLOCK C	Hydraulic, Hydrostatic and Pneumatic Systems	BLOCK G	Environmental Control Systems
BLOCK D	Drivetrain Systems	BLOCK H	Structural Components, Accessories and Attachments

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

APPENDIX F

TASK PROFILE CHART – Heavy Duty Equipment Technician

BLOCKS	TASKS	SUB-TASKS				
A - COMMON OCCUPATIONAL SKILLS	1. Uses and maintains tools and equipment.	1.01 Maintains tools and equipment.	1.02 Uses hoisting and lifting equipment.	1.03 Operates access equipment.	1.04 Uses personal protective equipment (PPE) and safety equipment.	
	2. Performs general maintenance and inspections.	2.01 Maintains fluids.	2.02 Services fasteners, sealing devices, adhesives and gaskets.	2.03 Services hoses, tubing, piping and fittings.	2.04 Services bearings and seals.	2.05 Services safety features.
		2.06 Performs scheduled maintenance procedures.	2.07 Identifies operational faults.	2.08 Performs operational check-out.		
	3. Organizes work.	3.01 Uses documentation and reference materials.	3.02 Completes documentation.	3.03 Communi-cates with others.	3.04 Prepares job action plan.	3.05 Maintains safe work environment.
	4. Performs routine trade activities.	4.01 Heats materials.	4.02 Cools materials.	4.03 Cuts materials.	4.04 Welds materials.	4.05 Cleans parts and materials.
B - ENGINES AND ENGINE SUPPORT SYSTEMS	5. Diagnoses engines and engine support systems.	5.01 Diagnoses base engine.	5.02 Diagnoses lubrication systems.	5.03 Diagnoses cooling systems.	5.04 Diagnoses intake and exhaust systems.	5.05 Diagnoses fuel systems.
		5.06 Diagnoses engine control systems.	5.07 Diagnoses emission control systems.			

BLOCKS	TASKS	SUB-TASKS				
	6. Repairs engines and engine support systems.	6.01 Repairs base engines.	6.02 Repairs lubrication systems.	6.03 Repairs cooling systems.	6.04 Repairs intake and exhaust systems.	6.05 Repairs fuel systems.
		6.06 Repairs engine control systems.	6.07 Repairs emission control systems.			
C - HYDRAULIC, HYDROSTATIC AND PNEUMATIC SYSTEMS	7. Diagnoses hydraulic, hydrostatic and pneumatic systems.	7.01 Diagnoses hydraulic systems.	7.02 Diagnoses hydrostatic systems.	7.03 Diagnoses pneumatic systems.		
	8. Repairs hydraulic, hydrostatic and pneumatic systems.	8.01 Repairs hydraulic systems.	8.02 Repairs hydrostatic systems.	8.03 Repairs pneumatic systems.		
D - DRIVETRAIN SYSTEMS	9. Diagnoses drivetrain systems.	9.01 Diagnoses clutch systems.	9.02 Diagnoses torque converters, fluid couplers and retarders.	9.03 Diagnoses driveline systems.	9.04 Diagnoses transmission and transfer case systems.	9.05 Diagnoses axle and differential systems.
		9.06 Diagnoses final drive systems.				
	10. Repairs drivetrain systems.	10.01 Repairs clutch systems.	10.02 Repairs torque converters, fluid couplers and retarders.	10.03 Repairs driveline systems.	10.04 Repairs transmission and transfer case systems.	10.05 Repairs axle and differential systems.
		10.06 Repairs final drive systems.				

BLOCKS	TASKS	SUB-TASKS				
E - STEERING, SUSPENSION, BRAKE SYSTEMS, WHEEL ASSEMBLIES AND UNDERCARRIAGE	11. Diagnoses steering, suspension, brake systems, wheel assemblies and	11.01 Diagnoses steering systems.	11.02 Diagnoses suspension systems.	11.03 Diagnoses brake systems.	11.04 Diagnoses wheel assemblies.	11.05 Diagnoses undercarriage systems.
	12. Repairs steering, suspension, brake systems, wheel assemblies and	12.01 Repairs steering systems.	12.02 Repairs suspension systems.	12.03 Repairs brake systems.	12.04 Repairs wheel assemblies.	12.05 Repairs undercarriage systems.
F - ELECTRICAL AND VEHICLE MANAGEMENT SYSTEMS	13. Diagnoses electrical systems.	13.01 Diagnoses starting/charging systems and batteries.	13.02 Diagnoses electrical components, motors and accessories.			
	14. Repairs electrical systems.	14.01 Repairs starting/charging systems and batteries.	14.02 Repairs electrical components, motors and accessories.			
	15. Diagnoses electronic vehicle management systems.	15.01 Reads diagnostic trouble codes (DTCs).	15.02 Monitors parameters.	15.03 Interprets test results.	15.04 Tests system circuitry and components.	
	16. Repairs electronic vehicle management systems.	16.01 Updates component software.	16.02 Repairs components.			
G - ENVIRON-MENTAL CONTROL SYSTEMS	17. Diagnoses environmental control systems.	17.01 Diagnoses heating systems.	17.02 Diagnoses ventilation and filtration systems.	17.03 Diagnoses air conditioning systems.	17.04 Diagnoses sound suppression systems.	
	18. Repairs environmental control systems.	18.01 Repairs heating systems.	18.02 Repairs ventilation and filtration systems.	18.03 Repairs air conditioning systems.	18.04 Repairs sound suppression systems.	

BLOCKS	TASKS	SUB-TASKS			
H - STRUCTURAL COMPONENTS, ACCESSORIES AND ATTACHMENTS	19. Diagnoses structural components, accessories and attachments.	19.01 Diagnoses structural components.	19.02 Diagnoses operator station components.	19.03 Diagnoses attachments and accessories.	
	20. Repairs structural components, accessories and attachments.	20.01 Performs mechanical repairs on structural components.	20.02 Repairs operator station components.	20.03 Repairs attachments and accessories.	20.04 Installs attachments and accessories.