



# Heavy Duty Equipment Technician

## Guide to Course Content

2024

Online: [www.saskapprenticeship.ca](http://www.saskapprenticeship.ca)

*Recognition:*

*To promote transparency and consistency, this document has been adapted from the 2014 Heavy Duty Equipment Technician National Occupational Analysis (Employment and Social Development Canada).*

*A complete version of the Occupational Standard can be found at [www.red-seal.ca](http://www.red-seal.ca)*

# STRUCTURE OF THE GUIDE TO COURSE CONTENT

To facilitate understanding of the occupation, this guide to course content contains the following sections:

**Description of the Heavy Duty Equipment Technician trade:** an overview of the trade's duties and training requirements.

**Essential Skills Summary:** an overview of how each of the nine essential skills is applied in this trade.

**Elements of Harmonization for Apprenticeship Training:** includes adoption of Red Seal trade name, number of levels of apprenticeship, total training hours (on-the-job and in-school) and consistent sequencing of technical training content. Implementation for harmonization was implemented progressively. Level one was implemented in 2017/2018, level two 2018/2019, level three 2019/2020, and level four in 2020/2021.

**Task Matrix:** a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard detailing the essential skills and the level of training where the content is covered.

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

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

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

**Training Profile Chart:** a chart which outlines the model for Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training.

**Technical Training Course Content for the Heavy Duty Equipment Technician trade:** a chart which outlines the model for SATCC technical training sequencing. For the harmonized level of training, a cross reference to the Harmonized apprenticeship technical training sequencing, at the learning outcome level, is provided.

**Appendix A: Post Harmonization Training Profile Chart:** a chart which outlines the finalized model for SATCC technical training sequencing with a cross reference to the Harmonized apprenticeship technical training sequencing, at the topic level.

# DESCRIPTION OF THE HEAVY DUTY EQUIPMENT TECHNICIAN TRADE

*Heavy Duty Equipment Technicians maintain, service and overhaul large mobile equipment used in construction, mining, forestry, and other material handling applications.*

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.

There are some 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.

**Training Requirements:** To graduate from each level of the apprenticeship program, an apprentice must successfully complete the required technical training and compile enough on-the-job experience to total at least 1800 hours each year. Total trade time required is 7200 hours and at least 4 years in the trade.

There are four levels of technical training delivered by Saskatchewan Polytechnic in Saskatoon.

- Level One: 8 weeks
- Level Two: 8 weeks
- Level Three: 8 weeks
- Level Four: 8 weeks

The information contained in this guide to course content details the technical training delivered for each level of apprenticeship. An apprentice spends approximately 15% of their apprenticeship term in a technical training institute learning the technical and theoretical aspects of the trade. The hours and percentages of technical and practical training may vary according to class needs and progress.

The content of the technical training components is subject to change without notice.

## Entrance Requirements for Apprenticeship Training

Your grade twelve transcripts (with no modified classes) or GED 12 is your guarantee that you meet the educational entrance requirements for apprenticeship in Saskatchewan. In fact, employers prefer and recommend apprentices who have completed high school. This ensures the individual has all of the necessary skills required to successfully complete the apprenticeship program, and receive journeyperson certification.

Individuals with “modified” or “general” classes in math or science do not meet our entry requirements. These individuals are required to take an entrance assessment prescribed by the SATCC.

English is the language of instruction in all apprenticeship programs and is the common language for business in Saskatchewan. Before admission, all apprentices and/or “upgraders” must be able to understand and communicate in the English language. Applicants whose first language is not English must have a minimum Canadian Language Benchmark Assessment of six (CLB6).

Note: A CLB assessment is valid for a one-year period from date of issue.

| Designated Trade Name  | Math Credit at the Indicated Grade Level <sup>❶</sup> | Science Credit at Grade Level |
|--|---|-------------------------------|
| Heavy Duty Equipment Technician  | Grade 11  | Grade 10                      |
| <p>❶ - (One of the following) WA – Workplace and Apprenticeship; or F – Foundations; or P – Pre-calculus, or a Math at the indicated grade level (Modified and General Math credits are not acceptable.).</p> <p>*Applicants who have graduated in advance of 2015-2016, or who do not have access to the revised Science curricula will require a Science at the minimum grade level indicated by trade.</p> <p>For information about high school curriculum, including Math and Science course names, please see:<br/> <a href="http://www.curriculum.gov.sk.ca/#">http://www.curriculum.gov.sk.ca/#</a></p> <p><b>Individuals not meeting the entrance requirements will be subject to an assessment and any required training.</b></p> |   |                               |

# ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

The tools are available online or for order at: [www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml](http://www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml)

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at [www.red-seal.ca](http://www.red-seal.ca).

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## READING

Heavy duty equipment technicians must read and comprehend a variety of materials including repair manuals, manufacturers' bulletins and safety documents. They refer to government regulations, vehicle inspection procedures, hazardous material handling and disposal and safety requirements of vehicles.

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## DOCUMENT USE

Heavy duty equipment technicians interpret technical drawings and flowcharts. They locate data such as classifications, product and material specifications, identification numbers, quantities and costs. Heavy duty equipment technicians often use specification tables. They scan a variety of manufacturers' labels for part numbers, serial numbers, sizes, colours and other information and adhere to hazard and safety icons.

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## WRITING

Heavy duty equipment technicians complete workplace documents such as written explanations to the client, work orders, inspection reports and incident reports.

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## ORAL COMMUNICATION

Heavy duty equipment technicians gather information from different sources about vehicle faults and needed repairs, explain the results of inspections and repairs, and discuss maintenance procedures. They exchange technical repair and troubleshooting information with others such as service managers, apprentices, co-workers, colleagues and suppliers.

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## **NUMERACY**

Heavy duty equipment technicians take a variety of measurements using digital and analog equipment. They estimate the amount of time required to complete repairs. Heavy duty equipment technicians compare measurements of energy, dimension, speed, horsepower, temperature and torque to specifications. They analyze pressure, power, torque, compression and electrical readings to assess vehicle performance and troubleshoot faults.

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## **THINKING**

Heavy duty equipment technicians use thinking skills and visual analysis to diagnose and repair problems. They evaluate the severity of vehicle defects and deficiencies and the quality of repairs. Heavy duty equipment technicians decide the most efficient course of action to complete a job.

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## **WORKING WITH OTHERS**

Most heavy duty equipment technicians work independently on jobs outlined in work orders. They may assist others with jobs that require two people or are within their specific area of expertise. They collaborate effectively with colleagues including salespersons, Partspeople and management to resolve concerns, situations and problems.

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## **DIGITAL TECHNOLOGY**

Heavy duty equipment technicians use computerized scanning equipment, onboard vehicle diagnostics and hand-held diagnostic tools to gain operational information about vehicles. They access the Internet and databases to retrieve repair information. Heavy duty equipment technicians use digital technology to exchange information with other technicians, service managers, colleagues in other locations and manufacturer support specialists. Keyboarding and basic computer skills are an asset.

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## **CONTINUOUS LEARNING**

Constant change in the industry makes it vital for heavy duty equipment technicians to stay current with the latest technology. They learn on the job, in organized information activities and in work discussion groups. Their training is provided by vehicle manufacturers, parts suppliers, employers and associations. They also advance skills by reading work-related magazines, periodicals and automotive websites.

# ELEMENTS OF HARMONIZATION FOR APPRENTICESHIP TRAINING

At the request of industry, the Harmonization Initiative was launched in 2013 to *substantively align* apprenticeship systems across Canada by making training requirements more consistent in the Red Seal trades. Harmonization aims to improve the mobility of apprentices, support an increase in their completion rates and enable employers to access a larger pool of apprentices.

As part of this work, the Canadian Council of the Directors of Apprenticeship (CCDA) identified four main harmonization priorities in consultation with industry and training stakeholders:

## 1. Trade name

The official Red Seal name for this trade is Heavy Duty Equipment Technician.

## 2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for the Heavy Duty Equipment Technician trade is four.

## 3. Total Training Hours during Apprenticeship Training

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

## 4. Consistent sequencing of training content (at each level) using the most recent Occupational Standard

Implementation for harmonization was implemented progressively. Level one was implemented in 2017/2018, level two 2018/2019, level three 2019/2020, and level four in 2020/2021. See Appendix A for the finalized curriculum comparisons.

White boxes are “Topics,” grey boxes are “In Context”. In context means learning that has already taken place and is being applied to the applicable task. Learning outcomes for in context topics are accomplished in other topics in that level.

| Level 1<br>(2017/2018<br>implementation) | Level 2<br>(2018/2019<br>implementation) | Level 3<br>(2019/2020<br>implementation) | Level 4<br>(2020/2021<br>implementation) |
|--|--|--|--|
|  | Common Occupational Skills               | Common Occupational Skills               | Common Occupational Skills               |
|  | Tools and Equipment                      |  | Tools and Equipment                      |
|  | Routine Work Activities                  | Routine Work Activities                  | Routine Work Activities                  |
|  | Operator Station Components              | Operator Station Components              | Operator Station Components              |



|  |  |  |  |
|--|--|--|--|
| <b>Level 1</b><br>(2017/2018 implementation) | <b>Level 2</b><br>(2018/2019 implementation) | <b>Level 3</b><br>(2019/2020 implementation) | <b>Level 4</b><br>(2020/2021 implementation) |
|--|--|--|--|

**Attachments and Accessories**

**Common Occupational Skills**

**Tools and Equipment**  
*(Includes Welding Equipment)*

**Routine Work Practices**

**Communication Techniques**

**Mentoring Techniques**

**Base Engines**

**Base Engines**

**Lubrication Systems**

**Lubrication Systems**

**Intake Systems**

**Intake Systems**

**Exhaust Systems**

**Exhaust Systems**

**Engine Management Systems**

**Engine Management Systems**

**Fuel Delivery Systems**

**Fuel Delivery Systems**

**Emission Control Systems**

**Emission Control Systems**

**Cooling Systems**

**Cooling Systems**

**Steering Systems**

**Steering Systems**

**Suspension Systems**

**Suspension Systems**

**Brake Systems**

**Brake Systems**

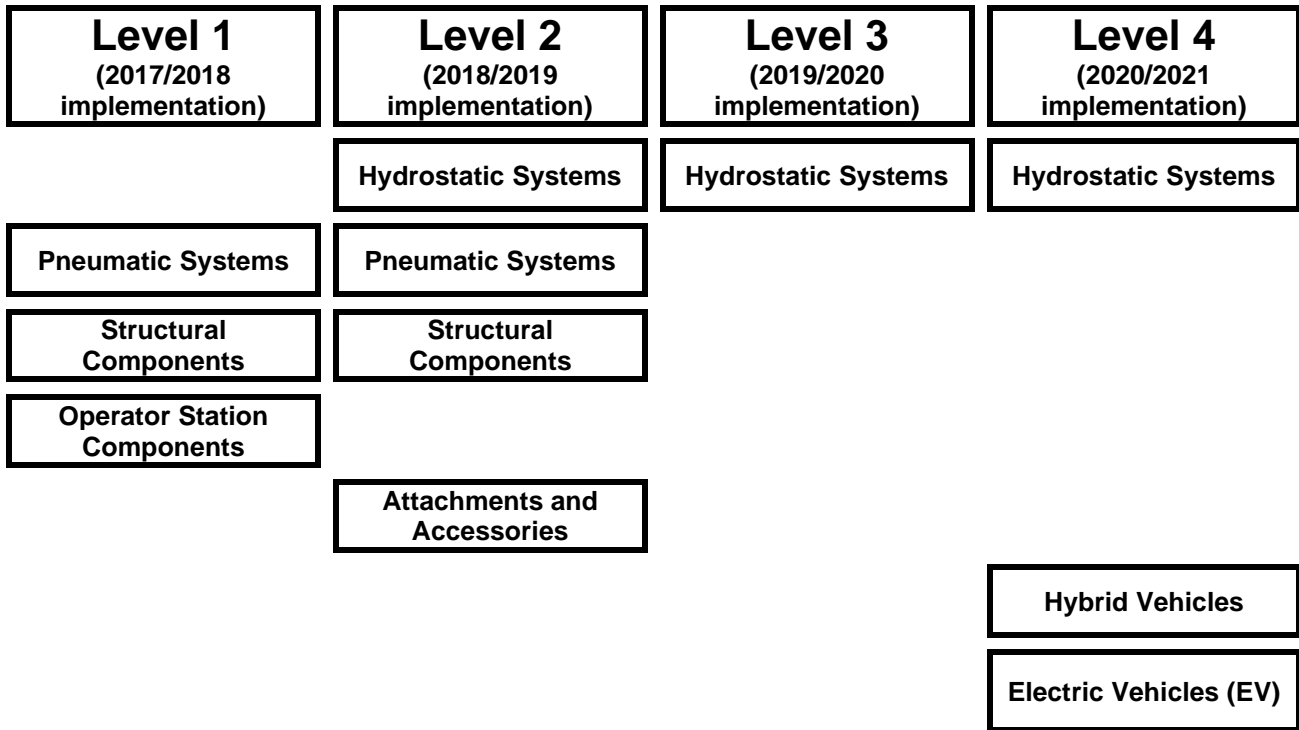
**Undercarriage Systems**

**Undercarriage Systems**

**Wheel Assemblies**

**Wheel Assemblies**

| <b>Level 1</b><br>(2017/2018 implementation) | <b>Level 2</b><br>(2018/2019 implementation)           | <b>Level 3</b><br>(2019/2020 implementation)              | <b>Level 4</b><br>(2020/2021 implementation)              |
|--|--|---|---|
| Charging Systems                             |  | Charging Systems  |   |
| Starting Systems                             |  | Starting Systems  |   |
| Battery Systems                              |  |   |   |
| Electrical Components                        |  | Electrical Components                                     |   |
|  | Equipment Management Systems and Electronic Components |   | Equipment Management Systems and Electronic Components    |
|  |  | Clutches  |   |
|  |  | Torque Converters, Fluid Couplers and Hydraulic Retarders | Torque Converters, Fluid Couplers and Hydraulic Retarders |
|  |  | Manual Transmission and Transfer Cases                    |   |
|  |  | Automatic and Powershift Transmissions                    | Automatic and Powershift Transmissions                    |
|  |  | Driveline Systems   | Driveline Systems   |
|  |  | Drive Axles and Differentials                             | Drive Axles and Differentials                             |
|  |  | Final Drive Systems                                       | Final Drive Systems                                       |
| Heating Systems                              |  |   | Heating Systems   |
| Ventilation and Filtration Systems           |  |   | Ventilation and Filtration Systems                        |
| Air Conditioning Systems                     |  |   | Air Conditioning Systems                                  |
| Sound Suppression Systems                    |  |   |   |
| Hydraulic Systems                            | Hydraulic Systems                                      | Hydraulic Systems   |   |



# HEAVY DUTY EQUIPMENT TECHNICIAN TASK MATRIX

This chart outlines the blocks, tasks and sub-tasks from the 2014 Heavy Duty Equipment Technician National Occupational Analysis (NOA). Each sub-task details the corresponding essential skill and level of training where the content is covered. \*

\* Sub Tasks with numbers in the boxes is where the content will be delivered in training. The Task Matrix Chart will be updated every year until Harmonization implementation is complete. Implementation for harmonization was implemented progressively. Level one was implemented in 2017/2018, level two 2018/2019, level three 2019/2020, and level four in 2020/2021.

## A – Performs common occupational skills

**8%**

|   |   |   |  |  |  |
|---|---|---|--|--|--|
| <b>A-1 Uses and maintains tools and equipment</b>       | <b>1.01 Maintains tools and equipment</b><br><br>1                                      | <b>1.02 Uses hoisting and lifting equipment</b><br><br>1  | <b>1.03 Operates access equipment</b><br><br>1   | <b>1.04 Uses personal protective equipment (PPE) and safety equipment</b><br><br>1 |  |
| <b>A-2 Performs general maintenance and inspections</b> | <b>2.01 Maintains fluids</b><br><br>1<br>(2, 3, 4 in context)                           | <b>2.02 Services fasteners, sealing devices, adhesives and gaskets</b><br><br>1<br>(2, 3, 4 in context) | <b>2.03 Services hoses, tubing, piping and fittings</b><br><br>1<br>(2, 3, 4 in context) | <b>2.04 Services bearings and seals</b><br><br>1<br>(2, 3, 4 in context)           | <b>2.05 Services safety features</b><br><br>1<br>(2, 3, 4 in context)        |
|   | <b>2.06 Performs scheduled maintenance procedures</b><br><br>1<br>(2, 3, 4 in context)  | <b>2.07 Identifies operational faults</b><br><br>1<br>(2, 3, 4 in context)                              | <b>2.08 Performs operational check-out</b><br><br>1<br>(2, 3, 4 in context)              |  |  |
| <b>A-3 Organizes work</b>                               | <b>3.01 Uses documentation and reference materials</b><br><br>1<br>(2, 3, 4 in context) | <b>3.02 Completes documentation</b><br><br>1<br>(2, 3, 4 in context)                                    | <b>3.03 Communicates with others</b><br><br>1<br>(2, 3, 4 in context)                    | <b>3.04 Prepares job action plan</b><br><br>1<br>(2, 3, 4 in context)              | <b>3.05 Maintains safe work environment</b><br><br>1<br>(2, 3, 4 in context) |

**A-4 Performs routine trade activities**

**4.01 Heats materials.**  
  
**1**

**4.02 Cools materials.**  
  
**1**

**4.03 Cuts materials.**  
  
**1**

**4.04 Welds materials.**  
  
**1**

**4.05 Cleans parts and materials.**  
  
**1**

## **B – Engines and engine support systems**

**16%**

**B-5 Diagnoses engines and engine support systems**

**5.01 Diagnoses base engine**  
  
**3**

**5.02 Diagnoses lubrication systems**  
  
**3**

**5.03 Diagnoses cooling systems**  
  
**3**

**5.04 Diagnoses intake and exhaust systems**  
  
**3**

**5.05 Diagnoses fuel systems**  
  
**3, 4**

**5.06 Diagnoses engine control systems**  
  
**3, 4**

**5.07 Diagnoses emission control systems**  
  
**3, 4**

**B-6 Repairs engines and engine support systems**

**6.01 Repairs base engines**  
  
**3**

**6.02 Repairs lubrication system**  
  
**3**

**6.03 Repairs cooling systems**  
  
**3**

**6.04 Repairs intake and exhaust systems**  
  
**3**

**6.05 Repairs fuel systems**  
  
**3, 4**

**6.06 Repairs engine control systems**  
  
**3, 4**

**6.07 Repairs emission control systems**  
  
**3, 4**

## C – Hydraulic, hydrostatic and pneumatic systems

19%

|  |                                  |                                    |                                  |
|--|----------------------------------|------------------------------------|----------------------------------|
| C-7 Diagnoses hydraulic, hydrostatic and pneumatic systems | 7.01 Diagnoses hydraulic systems | 7.02 Diagnoses hydrostatic systems | 7.03 Diagnoses pneumatic systems |
|  | 1, 2, 3                          | 3                                  | 1, 3                             |
|  |                                  |                                    |                                  |
| C-8 Repairs hydraulic, hydrostatic and pneumatic systems   | 8.01 Repairs hydraulic systems   | 8.02 Repairs hydrostatic systems   | 8.03 Repairs pneumatic systems   |
|  | 1, 2, 3                          | 3                                  | 1, 3                             |
|  |                                  |                                    |                                  |

## D – Drivetrain systems

14%

|                                  |                                    |  |                                  |   |  |
|----------------------------------|------------------------------------|--|----------------------------------|---|--|
| D-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 |
|                                  | 2, 3, 4                            | 2, 3, 4  | 2, 3, 4                          | 2, 3, 4   | 2, 3, 4                                      |
|                                  |                                    |  |                                  |   |  |
|                                  | 9.06 Diagnoses final drive systems |  |                                  |   |  |
|                                  | 2, 3, 4                            |  |                                  |   |  |
| D-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 system   |
|                                  | 2, 3, 4                            | 2, 3, 4  | 2, 3, 4                          | 2, 3, 4   | 2, 3, 4                                      |
|                                  |                                    |  |                                  |   |  |
|                                  | 10.06 Repairs final drive systems  |  |                                  |   |  |
|                                  | 2, 3, 4                            |  |                                  |   |  |

## E – Steering, suspension, brake systems, wheel assemblies and undercarriage

14%

|   |   |   |  |   |  |
|---|---|---|--|---|--|
| <b>E-11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage</b> | <b>11.01 Diagnoses steering systems</b><br><br>1, 2 | <b>11.02 Diagnoses suspension systems</b><br><br>1, 2 | <b>11.03 Diagnoses brake systems</b><br><br>1, 2 | <b>11.04 Diagnoses wheel assemblies</b><br><br>1, 2 | <b>11.05 Diagnoses undercarriage systems</b><br><br>1, 2 |
| <b>E-12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage</b>   | <b>12.01 Repairs steering systems</b><br><br>1, 2   | <b>12.02 Repairs suspension systems</b><br><br>1, 2   | <b>12.03 Repairs brake systems</b><br><br>1, 2   | <b>12.04 Repairs wheel assemblies.</b><br><br>1, 2  | <b>12.05 Repairs undercarriage systems.</b><br><br>1, 2  |

## F – Electrical and vehicle management systems

18%

|   |   |   |  |  |  |
|---|---|---|--|--|--|
| <b>F-13 Diagnoses electrical systems</b>                    | <b>13.01 Diagnoses starting/charging systems and batteries</b><br><br>1, 3, 4<br>(2 in context) | <b>13.02 Diagnoses electrical components, motors and accessories</b><br><br>1, 3, 4<br>(2 in context) |  |  |  |
| <b>F-14 Repairs electrical systems</b>                      | <b>14.01 Repairs starting/charging systems and batteries</b><br><br>1, 3, 4<br>(2 in context)   | <b>14.02 Repairs electrical components, motors and accessories</b><br><br>1, 3, 4<br>(2 in context)   |  |  |  |
| <b>F-15 Diagnoses electronic vehicle management systems</b> | <b>15.01 Reads diagnostic trouble codes (DTCs)</b><br><br>3, 4                                  | <b>15.02 Monitors parameters</b><br><br>3, 4  | <b>15.03 Interprets test results</b><br><br>3, 4 | <b>15.04 Tests system circuitry and components</b><br><br>3, 4 |  |
| <b>F-16 Repairs electronic vehicle management systems</b>   | <b>16.01 Updates component software</b><br><br>3, 4   | <b>16.02 Repairs components</b><br><br>3, 4   |  |  |  |





# TRAINING PROFILE CHART

This Training Profile Chart represents Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) apprenticeship technical training at the topic level.

| Level One (Harmonized)                | Transcript Code   | Hours |
|---------------------------------------|-------------------|-------|
| Basic Tools                           | TOOL 145 – Theory | 12    |
|                                       | TOOL 146 – Shop   | 12    |
| Brake Systems                         | BRAK 111 – Theory | 24    |
|                                       | BRAK 112 – Shop   | 36    |
| Electrical                            | ELCT 100 – Theory | 14    |
|                                       | ELCT 101 – Shop   | 16    |
| Environmental Control Systems         | HVAC 100 – Theory | 6     |
| Hydraulics                            | HYDR 108 – Theory | 24    |
|                                       | HYDR 109 – Shop   | 36    |
| Steering Systems                      | STER 100 – Theory | 12    |
|                                       | STER 101 – Shop   | 18    |
| Structural Components and Accessories | MAIN 100 – Theory | 12    |
|                                       | MAIN 101 – Shop   | 18    |
|                                       |                   | 240   |

| Level Two (Harmonized)                   | Transcript Code   | Hours |
|--|-------------------|-------|
| Braking Systems ABS                      | BRAK 206 – Theory | 14    |
|  | BRAK 207 – Shop   | 16    |
| Drivetrain Systems                       | DRTR 201 – Theory | 24    |
|  | DRTR 202 – Shop   | 36    |
| Electrical                               | ELCT 202 – Theory | 12    |
|  | ELCT 203 – Shop   | 18    |
| Hydraulics                               | HYDR 204 – Theory | 30    |
|  | HYDR 205 – Shop   | 30    |
| Steering and Directional Control Systems | STER 202 – Theory | 12    |
|  | STER 203 – Shop   | 18    |
| Structural Components                    | MAIN 200 – Theory | 12    |
|  | MAIN 201 – Shop   | 18    |
|  |                   | 240   |

| Level Three (Harmonized)          | Transcript Code   | Hours |
|-----------------------------------|-------------------|-------|
| Alternative Fuels                 | FUEL 302 – Theory | 12    |
|                                   | FUEL 303 – Shop   | 18    |
| Electrical                        | ELCT 301 – Theory | 14    |
|                                   | ELCT 302 – Shop   | 16    |
| Engine and Engine Support Systems | ENGN 306 – Theory | 55    |
|                                   | ENGN 307 – Shop   | 65    |
| Powershift Transmissions          | TRNM 306 – Theory | 26    |
|                                   | TRNM 307 – Shop   | 34    |
|                                   |                   | 240   |

| Level Four (Harmonized)       | Transcript Code   | Hours |
|-------------------------------|-------------------|-------|
| Drivetrains                   | DRTR 400 – Theory | 12    |
|                               | DRTR 401 – Shop   | 18    |
| Electrical                    | ELCT 400 – Theory | 40    |
|                               | ELCT 401 – Shop   | 50    |
| Environmental Control Systems | HVAC 400 – Theory | 12    |
|                               | HVAC 401 – Shop   | 18    |
| Fuel Systems                  | FUEL 404 – Theory | 40    |
|                               | FUEL 405 – Shop   | 50    |
|                               |                   | 240   |

# TECHNICAL TRAINING COURSE CONTENT

This chart outlines the model for Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training sequencing. For the harmonized level of training, a cross reference to the National Occupational Analysis (NOA) apprenticeship technical training sequencing, at the learning outcome level, is provided.

| <b>Level One</b>   | <b>8 weeks</b> | <b>240 hours</b> |
|--|----------------|------------------|
| <b>Basic Tools – Theory</b>  |                | <b>12 hours</b>  |
| <ul style="list-style-type: none"> <li>describe safety rules and regulations</li> <li>describe the purpose and care of shop and hand tools</li> <li>describe various types of fasteners, adhesives and sealing devices</li> </ul>  |                |                  |
| <b>Basic Tools – Shop</b>  |                | <b>12 hours</b>  |
| <ul style="list-style-type: none"> <li>demonstrate safety</li> <li>explain legislative regulations</li> <li>demonstrate use and care of hand tools and shop equipment</li> </ul>   |                |                  |
| <b>NOA topics covered in this section of training:</b>   |                |                  |
| <b>A-1 Uses and maintains tools and equipment</b>  |                |                  |
| A-1.01 Maintains tools and equipment   |                |                  |
| <ul style="list-style-type: none"> <li>clean and lubricate tools and equipment</li> <li>inspect tools to determine wear and damage</li> <li>organize and store tools and equipment</li> <li>test and calibrate measuring tools such as micrometers and calipers to ensure they are accurate</li> <li>check devices such as hoisting, lifting and access equipment for required inspection tags and ratings</li> <li>notify appropriate personnel of defective tools and equipment so that they get repaired or replaced</li> </ul> |                |                  |
| A-1.03 Operates access equipment   |                |                  |
| <ul style="list-style-type: none"> <li>determine hazards in location such as uneven ground, overhead lines and other hoisting devices on site</li> <li>ensure equipment is appropriate for task at hand</li> <li>obtain clearances, certification and licenses for use of access equipment</li> <li>use access equipment safety procedures such as fall protection, pre-operational tests and environmental checks</li> <li>communicate lift through hand signals, verbal or radio communication</li> </ul>                        |                |                  |
| A-1.04 Uses personal protective equipment (PPE) and safety equipment   |                |                  |
| <ul style="list-style-type: none"> <li>select PPE and safety equipment as required for task at hand and work surroundings</li> <li>identify site hazards and regulations requiring the use of PPE and safety equipment</li> <li>inspect, maintain PPE and safety equipment</li> <li>apply local, provincial and national safety regulations such as WHMIS and Transport of Dangerous Goods (TDG)</li> </ul>  |                |                  |
| <b>A-2 Performs general maintenance and inspections</b>  |                |                  |
| A-2.05 Services safety features  |                |                  |
| <ul style="list-style-type: none"> <li>perform function test and maintenance of safety features such as restraints and warning devices</li> <li>report defects of safety features in order to ensure the defects are corrected</li> <li>recognize criteria for repair or replacement of safety features</li> <li>repair safety features according to manufacturers' and government specifications</li> </ul>   |                |                  |

- remove and replace safety features according to manufacturers' and government specifications
- adjust safety features according to operating manufacturers' specifications and government regulations

### **A-3 Organizes work**

#### **A-3.05 Maintains safe work environment**

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

### **A-4 Performs routine trade activities**

#### **A-4.01 Heats materials**

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

#### **A-4.02 Cools materials**

- use component cooling methods such as using water, CO2 and liquid nitrogen
- determine required cooling of materials according to manufacturers' specifications
- measure cooling of metals using methods such as using a heat stick, using infrared temperature gun and measuring with temperature probe

#### **A-4.03 Cuts materials**

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

#### **A-4.04 Welds materials**

- select and use welding tools and equipment such as torches, metal inert gas (MIG) welders, and shielded metal arc welding (SMAW) equipment
- prepare work environment and material to be welded
- recognize jurisdictional limitations, certification and licensing requirements for different types of welding
- select welding material as required by the task
- recognize limitations in work environment such as gases, enclosed spaces and other personnel
- determine composition and function of material to be welded
- isolate all electronics on equipment by disconnecting ground source or using surge protector to prevent damage
- isolate component to be welded, place ground as close to weld as possible to avoid unwanted arcing and heating through components such as bearings, bushings, cylinders and seals
- recognize manufacturers' prohibition of welding components such as ROPS, FOPS and OPS

#### A-4.05 Cleans parts and materials

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

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### **Brake Systems – Theory**

**24 hours**

- describe hydraulic brake system operation
- describe air brake system operation
- describe various types of park brake systems

### **Brake Systems – Shop**

**36 hours**

- evaluate hydraulic brake system operation
- evaluate air brake system operation
- evaluate various park brake systems
- conduct final adjustments and performance tests
- repair faults

#### **NOA topics covered in this section of training:**

### **C-7 Diagnoses hydraulic, hydrostatic and pneumatic systems**

#### **C-7.03 Diagnoses pneumatic systems**

- select and use diagnostic tools such as pressure gauges and multimeter
- locate components and perform tests such as cycle time, pressure and leak test
- perform visual and auditory inspection to identify problems such as leaks, contamination and heat
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble component to identify problem
- recognize worn, damaged and defective components such as compressors, air motors and control valves
- take measurements of the pneumatic system components and compare to manufacturers' specifications
- depressurize and repressurize pneumatic system according to manufacturers' specifications
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

### **C-8 Repairs hydraulic, hydrostatic and pneumatic systems**

#### **C-8.03 Repairs pneumatic systems**

- select and use repair tools and equipment such as hand tools and shop tools
- remove, disassemble and inspect pneumatic system components for conditions such as scoring, wear patterns and heat discoloration
- select repair parts and materials such as motors, compressor and valves according to repair requirements and manufacturers' specifications
- depressurize pneumatic system as per manufacturers' specifications and government regulations
- remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
- reassemble pneumatic system components and perform measurements
- torque components according to sequence and specifications
- assemble and install components according to manufacturers' specifications and procedures
- adjust and calibrate pneumatic system components and parts to manufacturers' specifications

- perform pre-lubrication
- perform start-up and break-in according to manufacturers' specifications and procedures
- complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

### **E-11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage**

#### **E-11.03 Diagnoses brake systems**

- select and use diagnostic tools such as onboard computers, laptops, handheld scanners, pressure gauges, multimeters and infrared temperature gun
- locate components and perform tests such as leak test, pressure test and stopping distance test
- perform visual and auditory inspection to identify problems such as improper brake adjustment, contamination and leaks
- take fluid samples and interpret results to identify problems and trends
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

### **E-12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage**

#### **E-12.03 Repairs brake systems**

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

### **Electrical – Theory**

**14 hours**

- apply scientific principles to explain electrical theory and magnetism
- identify electrical circuit types and faults utilizing test equipment
- explain the function and operation of a lead acid battery

### **Electrical – Shop**

**16 hours**

- measure electrical values and check circuit operation
- evaluate a lead acid battery
- repair faults

### **NOA topics covered in this section of training:**

#### **F-13 Diagnoses electrical systems**

##### **F-13.01 Diagnoses starting/charging systems and batteries**

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

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

#### F-13.02 Diagnoses electrical components, motors and accessories

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

### F-14 Repairs electrical systems

#### F-14.01 Repairs starting/charging systems and batteries

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

#### F-14.02 Repairs electrical components, motors and accessories

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

## Environmental Control Systems – Theory

**6 hours**

- complete the Heating, Refrigeration and Air Conditioning Institute's course on ozone depleting substances

### NOA topics covered in this section of training:

#### G-17 Diagnoses environmental control systems

##### G-17.01 Diagnoses heating systems

- select and use diagnostic tools such as thermometer, multimeter and vacuum gauge
- locate components and perform tests such as coolant levels, air flow tests and temperature tests
- perform sensory inspection to verify customer complaint such as noises, no heat, too much heat and odours to guide the diagnostic process
- compare equipment operation to expected performance
- recognize worn, damaged and defective components such as fans, hoses and motors
- remove and disassemble component to identify problem
- determine diagnostic sequence according to manufacturers' specifications
- depressurize cooling system before removing radiator cap to avoid personal injury

- identify faulty systems such as engine cooling system or HVAC
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### G-17.02 Diagnoses ventilation and filtration systems

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

#### G-17.03 Diagnoses air conditioning systems

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

#### G-17.04 Diagnoses sound suppression systems

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



## **G-18 Repairs environmental control systems**

### **G-18.01 Repairs heating systems**

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

### **G-18.02 Repairs ventilation and filtration systems**

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

### **G-18.03 Repairs air conditioning systems**

- select and use repair tools and equipment to evacuate and recharge system and to identify types of refrigerant
- select repair parts and materials and follow repair sequence according to manufacturers' specifications and procedures
- recover refrigerant and evacuate air conditioning system according to jurisdictional regulations
- remove, repair and replace faulty components such as switches, hoses and expansion valves
- follow repair sequence according to manufacturers' specifications and expected performance
- reassemble air conditioning system components and perform measurements
- recharge system to recommended amounts of refrigerant and oils according to manufacturers' specifications
- clean and deodorize air flow systems with materials such as compressed air, sanitizers, pressurized deodorizers and cleaning agents
- convert systems to run on other refrigerants according to manufacturers' requirements by performing tasks such as replacing fittings and changing refrigerant oil
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

### **G-18.04 Repairs sound suppression systems**

- select and use repair tools and equipment such as scrapers, applicator gun and seal removers to repair panels, seals and insulation'
- select repair parts and materials and follow repair sequence according to manufacturers' specifications and procedures

- remove, disassemble, recondition and replace faulty components such as matting, insulation and seals
- reassemble sound suppression system components and perform measurements
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

### **Hydraulics – Theory**

**24 hours**

- explain the fundamentals of a basic hydraulic system and related components
- interpret hydraulic symbol diagrams
- describe hydraulic system maintenance and testing procedures
- describe open and closed center hydraulic systems

### **Hydraulics – Shop**

**36 hours**

- service hydraulic system and various components
- test hydraulic systems using correct tools and procedures

### **NOA topics covered in this section of training:**

#### **C-7 Diagnoses hydraulic, hydrostatic and pneumatic systems**

##### **C-7.01 Diagnoses hydraulic systems**

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

#### **C-8 Repairs hydraulic, hydrostatic and pneumatic systems**

##### **C-8.01 Repairs hydraulic systems**

- select and use repair tools and equipment such as hand tools and shop tools
- remove, disassemble and inspect hydraulic system components for conditions such as scoring, wear patterns and heat discoloration
- flush hydraulic system as required according to manufacturers' specifications
- inspect and service accumulators
- select repair parts and materials such as motors, pumps and cylinders according to repair requirements and manufacturers' specifications
- depressurize hydraulic system as per manufacturers' specifications and government regulations
- remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
- reassemble hydraulic system components and perform measurements
- torque components according to sequence and specifications
- assemble and install components according to manufacturers' specifications and procedures
- adjust and calibrate hydraulic system components and parts to manufacturers' specifications
- perform pre-lubrication, bleeding and priming procedures
- perform start-up and break-in according to manufacturers' specifications and procedures

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## Steering Systems – Theory

12 hours

- explain basic wheel and frame alignment angles
- explain manual and integral steering system operation
- describe mounting procedures for tires, rims and hubs

## Steering Systems – Shop

18 hours

- perform a basic wheel alignment
- evaluate manual and integral power steering systems
- perform mounting procedures for tires, rims and hubs
- repair system faults

### NOA topics covered in this section of training:

#### E-11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage

##### E-11.01 Diagnoses steering systems

- select and use diagnostic tools such as flow gauges, pressure gauges, multimeter, handheld scanner and onboard diagnostic
- locate components and perform tests such as flow tests, pressure checks, cylinder leakage tests, motor leakage tests, cycle time tests and secondary steering tests
- 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
- take fluid samples and interpret results to identify problems and trends
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### E-11.02 Diagnoses suspension systems

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

##### E-11.04 Diagnoses wheel assemblies

- select and use diagnostic tools such as tread wear gauge, torque wrench, tire pressure gauge, tire monitoring sensors and onboard diagnostic
- locate components and perform tests such as tire pressure test and wheel nut torque check
- perform sensory inspection to identify problems such as leaks, cracks and worn components
- verify that components meet manufacturers' specifications for the equipment
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### E-11.05 Diagnoses undercarriage systems

- select and use diagnostic tools such as infrared temperature gun, calipers and ultrasonic tester
- locate components and perform tests such as measuring pin wear, bushing wear and track pad wear
- perform sensory inspection to identify problems such as wear, cuts, cracks and leaks

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

## **E-12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage**

### **E-12.01 Repairs steering systems**

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

### **E-12.02 Repairs suspension systems**

- select and use repair tools and equipment such as hand tools, power tools and shop tools
- depressurize steering systems according to manufacturers' specifications and government regulations
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- assemble and install components according to manufacturers' specifications and procedures
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust and calibrate suspension system components and parts to manufacturers' specifications
- perform pre-lubrication, air build-up and charging procedures
- complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

### **E-12.04 Repairs wheel assemblies**

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

#### E-12.05 Repairs undercarriage systems

- select and use repair tools and equipment such as pin presses, torches, sledge hammers and impact wrenches
- depressurize undercarriage systems according to manufacturers' specifications and government regulations
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- assemble and install components according to manufacturers' specifications and procedures
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust undercarriage components and parts to manufacturers' specifications
- perform pre-lubrication and break-in procedures
- complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

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#### **Structural Components and Accessories – Theory**

**12 hours**

- identify hoisting and rigging techniques
- describe the purpose of roll over protection system (ROPS) and operator safety systems
- describe preventative maintenance procedures

#### **Structural Components and Accessories – Shop**

**18 hours**

- perform hoisting and rigging techniques
- evaluate roll over protection system (ROPS) and operator safety systems
- perform preventative maintenance procedures
- repair defects

#### **NOA topics covered in this section of training:**

#### **H-19 Diagnoses structural components, accessories and attachments**

##### H-19.01 Diagnoses structural components

- select and use diagnostic tools such as dial indicator and magnetic particle tester
- locate components and perform tests such as dye check test, pin and bearing clearance test and magnetic particle test
- perform sensory inspection to identify problems such as cracks, leaks and defects
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### H-19.02 Diagnoses operator station components

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

##### H-19.03 Diagnoses attachments and accessories

- select and use diagnostic tools such as flow meter, multimeter and diagnostic software
- locate components and perform tests such as flow test, pressure test and circuit test
- perform sensory inspection to identify problems such as cracks, leaks and defects

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

## **H-20 Repairs structural components, accessories and attachments**

### H-20.01 Performs mechanical repairs on structural components

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

### H-20.02 Repairs operator station components

- select and use repair tools and equipment such as multimeter, hand tools, shop tools, oxyacetylene torches and welding equipment
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust operator station components such as controls and sensors to manufacturers' specifications
- complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

### H-20.03 Repairs attachments and accessories

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

### H-20.04 Installs attachments and accessories

- select and use tools and equipment such as precision measuring tools, hand tools and shop tools
- remove and disassemble components according to manufacturers' specifications and procedures for installation of attachments and accessories
- select parts and materials according to installation requirements and manufacturers' specifications

- assemble and install components according to manufacturers' specifications and procedures
  - adjust attachments and accessories such as clams, buckets and tree harvesters to manufacturers' specifications
  - complete installation by verifying system's function, operation and performance according to manufacturers' specifications and government regulations
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**No Level One topics are taught in context:**

*For details regarding the In Context Topic, see page 62*

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## Level Two

8 weeks

240 hours

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### Brake Systems ABS – Theory

14 hours

- describe antilock braking system components
- describe electric braking system components

### Brake Systems ABS – Shop

16 hours

- evaluate antilock braking systems
- evaluate an electric braking system
- repair system faults

### NOA topics covered in this section of training:

#### C-7 Diagnoses hydraulic, hydrostatic and pneumatic systems

##### C-7.03 Diagnoses pneumatic systems

- select and use diagnostic tools such as pressure gauges and multimeter
- locate components and perform tests such as cycle time, pressure and leak test
- perform visual and auditory inspection to identify problems such as leaks, contamination and heat
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble component to identify problem
- recognize worn, damaged and defective components such as compressors, air motors and control valves
- take measurements of the pneumatic system components and compare to manufacturers' specifications
- depressurize and repressurize pneumatic system according to manufacturers' specifications
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### C-8 Repairs hydraulic, hydrostatic and pneumatic systems

##### C-8.03 Repairs pneumatic systems

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

#### E-11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage

##### E-11.03 Diagnoses brake systems.

- select and use diagnostic tools such as onboard computers, laptops, handheld scanners, pressure gauges, multimeters and infrared temperature gun
- locate components and perform tests such as leak test, pressure test and stopping distance test



- perform visual and auditory inspection to identify problems such as improper brake adjustment, contamination and leaks
- take fluid samples and interpret results to identify problems and trends
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

## **E-12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage**

### **E-12.03 Repairs brake systems**

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

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### **Drivetrain Systems – Theory**

**24 hours**

- identify various seals and bearing types
- discuss various clutch types
- discuss manual transmission operation
- discuss differential operation
- discuss planetary and final drives
- discuss driveline operation

### **Drivetrain Systems – Shop**

**36 hours**

- perform the removal and replacement of various seals and bearings
- evaluate various clutch types
- evaluate manual transmission operation
- evaluate differential operation
- evaluate planetary and final drive systems
- evaluate driveline systems
- repair faults

**Note: This section of training (Drivetrain Systems) exceeds NOA scope of work in Level Two and exceeds the minimum sequencing as set out in the Heavy Duty Equipment Technician NOA. Its purpose is mainly to assist in the understanding of the topic Steering and Directional Control Systems. Note: Content covered in this course is reviewed in TRNM 306/307 Theory/Shop – POWERSHIFT TRANSMISSIONS Level Three.**

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### **Electrical – Theory**

**12 hours**

- explain the operation of a cranking system and related components
- explain the operation of an alternating current (AC) charging system and related components

## Electrical – Shop

18 hours

- evaluate cranking and charging systems
- repair faults

### NOA topics covered in this section of training:

#### F-13 Diagnoses electrical systems

##### F-13.01 Diagnoses starting/charging systems and batteries

- select and use diagnostic tools and equipment such as amperage/voltage/resistance (AVR) meter, multimeter and circuit tester
- inspect components and accessories such as capacitors, breakers and switches for signs of wear, damage or failure
- perform boosting, charging and load testing of battery and battery systems
- perform and interpret hydrometer test
- interpret and follow wiring schematics and diagrams
- perform starting/charging system and battery tests such as AVR, voltage drop and parasitic draw
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### F-13.02 Diagnoses electrical components, motors and accessories

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

#### F-14 Repairs electrical systems

##### F-14.01 Repairs starting/charging systems and batteries

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

##### F-14.02 Repairs electrical components, motors and accessories

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

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## Hydraulics – Theory

30 hours

- describe the operation of the different types of flow control valves
- describe a power-beyond hydraulic system
- describe open and closed loop hydraulic systems
- describe the operation of a load sensing hydraulic system
- describe various hydrostatic drive systems

## Hydraulics – Shop

30 hours

- evaluate various types of hydraulic systems and flow control valves
- evaluate a power beyond system
- evaluate open and closed loop hydraulic systems
- evaluate a load sensing hydraulic system
- evaluate various hydrostatic drive systems
- repair faults

### NOA topics covered in this section of training:

#### C-7 Diagnoses hydraulic, hydrostatic and pneumatic systems

##### C-7.01 Diagnoses hydraulic systems

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

#### C-8 Repairs hydraulic, hydrostatic and pneumatic systems

##### C-8.01 Repairs hydraulic systems

- select and use repair tools and equipment such as hand tools and shop tools
- remove, disassemble and inspect hydraulic system components for conditions such as scoring, wear patterns and heat discoloration
- flush hydraulic system as required according to manufacturers' specifications
- inspect and service accumulators
- select repair parts and materials such as motors, pumps and cylinders according to repair requirements and manufacturers' specifications
- depressurize hydraulic system as per manufacturers' specifications and government regulations
- remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
- reassemble hydraulic system components and perform measurements
- torque components according to sequence and specifications
- assemble and install components according to manufacturers' specifications and procedures
- adjust and calibrate hydraulic system components and parts to manufacturers' specifications
- perform pre-lubrication, bleeding and priming procedures
- perform start-up and break-in according to manufacturers' specifications and procedures

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## **Steering and Directional Control Systems – Theory**

**12 Hours**

- explain differential directional control in a crawler tractor
- explain hydrostatic directional control in a crawler tractor
- discuss pilot control and orbital steering systems describe maintenance procedure for transmission, transaxle, transfer case, differential and engine

## **Steering and Directional Control Systems – Shop**

**18 Hours**

- evaluate differential directional control in a crawler tractor
- evaluate hydrostatic directional control in a crawler tractor
- evaluate pilot control and orbital steering systems
- repair faults

### **NOA topics covered in this section of training:**

#### **E-11 Diagnoses steering, suspension, brake systems, wheel assemblies and undercarriage**

##### **E-11.01 Diagnoses steering systems**

- select and use diagnostic tools such as flow gauges, pressure gauges, multimeter, handheld scanner and onboard diagnostic
- locate components and perform tests such as flow tests, pressure checks, cylinder leakage tests, motor leakage tests, cycle time tests and secondary steering tests
- 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
- take fluid samples and interpret results to identify problems and trends
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### **E-11.02 Diagnoses suspension systems**

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

##### **E-11.04 Diagnoses wheel assemblies**

- select and use diagnostic tools such as tread wear gauge, torque wrench, tire pressure gauge, tire monitoring sensors and onboard diagnostic
- locate components and perform tests such as tire pressure test and wheel nut torque check
- perform sensory inspection to identify problems such as leaks, cracks and worn components
- verify that components meet manufacturers' specifications for the equipment
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### **E-11.05 Diagnoses undercarriage systems**

- select and use diagnostic tools such as infrared temperature gun, calipers and ultrasonic tester
- locate components and perform tests such as measuring pin wear, bushing wear and track pad wear
- perform sensory inspection to identify problems such as wear, cuts, cracks and leaks

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

## **E-12 Repairs steering, suspension, brake systems, wheel assemblies and undercarriage**

### **E-12.01 Repairs steering systems**

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

### **E-12.02 Repairs suspension systems**

- select and use repair tools and equipment such as hand tools, power tools and shop tools
- depressurize steering systems according to manufacturers' specifications and government regulations
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- assemble and install components according to manufacturers' specifications and procedures
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust and calibrate suspension system components and parts to manufacturers' specifications
- perform pre-lubrication, air build-up and charging procedures
- complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

### **E-12.04 Repairs wheel assemblies**

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

#### E-12.05 Repairs undercarriage systems

- select and use repair tools and equipment such as pin presses, torches, sledge hammers and impact wrenches
- depressurize undercarriage systems according to manufacturers' specifications and government regulations
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- assemble and install components according to manufacturers' specifications and procedures
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust undercarriage components and parts to manufacturers' specifications
- perform pre-lubrication and break-in procedures
- complete repair by verifying system's function, driveability and performance according to manufacturers' specifications and government regulations

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#### **Structural Components – Theory**

**12 Hours**

- identify hoisting and rigging techniques
- describe undercarriage operation and troubleshooting
- identify undercarriage components and crawler tractor final drive systems

#### **Structural Components – Shop**

**18 Hours**

- perform hoisting and rigging techniques
- evaluate undercarriage and final drive components
- repair faults

#### **NOA topics covered in this section of training:**

#### **H-19 Diagnoses structural components, accessories and attachments**

##### H-19.01 Diagnoses structural components

- select and use diagnostic tools such as dial indicator and magnetic particle tester
- locate components and perform tests such as dye check test, pin and bearing clearance test and magnetic particle test
- perform sensory inspection to identify problems such as cracks, leaks and defects
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble defective component to identify problem
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### H-19.02 Diagnoses operator station components

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

##### H-19.03 Diagnoses attachments and accessories

- select and use diagnostic tools such as flow meter, multimeter and diagnostic software
- locate components and perform tests such as flow test, pressure test and circuit test
- perform sensory inspection to identify problems such as cracks, leaks and defects
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance

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

## **H-20 Repairs structural components, accessories and attachments**

### H-20.01 Performs mechanical repairs on structural components

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

### H-20.02 Repairs operator station components

- select and use repair tools and equipment such as multimeter, hand tools, shop tools, oxyacetylene torches and welding equipment
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust operator station components such as controls and sensors to manufacturers' specifications
- complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

### H-20.03 Repairs attachments and accessories

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

### H-20.04 Installs attachments and accessories

- select and use tools and equipment such as precision measuring tools, hand tools and shop tools
- remove and disassemble components according to manufacturers' specifications and procedures for installation of attachments and accessories
- select parts and materials according to installation requirements and manufacturers' specifications
- assemble and install components according to manufacturers' specifications and procedures

- adjust attachments and accessories such as clams, buckets and tree harvesters to manufacturers' specifications
  - complete installation by verifying system's function, operation and performance according to manufacturers' specifications and government regulations
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**Level Two topics that are taught in context:**

***Common Occupational Skills***

***Tools and Equipment***

***Routine Trade Activities***

***Operator Station Components***

***For details regarding the In Context Topics, see page 62***



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## Level Three

8 weeks

240 hours

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### Alternative Fuels – Theory

12 hours

- describe the ignition process of a spark ignition engine.
- describe the fuel delivery process for various fuel types

### Alternative Fuels – Shop

18 hours

- perform servicing, diagnoses and replacement of spark ignition component.
- perform servicing, diagnosing and replacement of components related to fuel delivery

#### NOA topics covered in this section of training:

#### B-5 Diagnoses engine and engine support systems

##### B-5.05 Diagnoses fuel systems

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

#### B-6 Repairs engine and engine support systems

##### B-6.05 Repairs fuel systems

- select and use repair tools and equipment such as fuel pressure gauge, hand tools, and fuel transfer and storage equipment
- remove, disassemble and inspect fuel system components such as fuel lines and manifolds for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants, o-rings and fastening devices according to repair requirements and manufacturers' specifications
- clean and repair or replace fuel system components such as fuel filters, governors, pumps, common rail fuel components and injectors
- reassemble fuel system components and perform measurements
- torque components according to sequence and specifications
- pressurize and bleed system
- perform fuel system timing procedures
- complete repair by verifying system's function and performance

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### Electrical – Theory

14 hours

- explain common electrical components and their applications.
- interpret wiring diagrams.
- explain common electrical faults

### Electrical – Shop

16 hours

- measure electrical values.
- construct electrical circuits.
- analyze circuit operation.

#### NOA topics covered in this section of training:

#### F-13 Diagnoses electrical systems

##### F-13.01 Diagnoses starting/charging systems and batteries

- select and use diagnostic tools and equipment such as amperage/voltage/resistance (AVR) meter, multimeter and circuit tester
- inspect components and accessories such as capacitors, breakers and switches for signs of wear, damage or failure
- perform boosting, charging and load testing of battery and battery systems
- perform and interpret hydrometer test
- interpret and follow wiring schematics and diagrams
- perform starting/charging system and battery tests such as AVR, voltage drop and parasitic draw
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### F-13.02 Diagnoses electrical components, motors and accessories

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

### F-14 Repairs electrical systems

#### F-14.01 Repairs starting/charging systems and batteries

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

#### F-14.02 Repairs electrical components, motors and accessories

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

### F-15 Diagnoses electronic vehicle management systems

#### F-15.01 Reads diagnostic trouble codes (DTCs)

- 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
- perform functional tests to find active and intermittent codes
- refer to manufacturers' diagnostic sequence for code definition

#### F-15.02 monitors parameters

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

#### F-15.03 Interprets test results

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

#### F-15.04 Tests system circuitry and components

- 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
- determine faulty circuitry and/or components

### **F-16 Repairs electronic vehicle management systems**

#### F-16.01 Updates component software

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

#### F-16.02 Repairs components

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

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### **Engine and Engine Support Systems – Theory**

**55 hours**

- describe the operational characteristics of a diesel engine
- describe metallurgy and fluid analysis as it pertains to diesel engines
- describe the operational characteristics of various diesel engine support systems
- describe the procedures involved in a diesel engine overhaul
- describe the processes involved in determining component serviceability
- describe diesel engine failure diagnosis

### **Engine and Engine Support Systems – Shop**

**65 hours**

- evaluate a diesel engine for potential faults prior to disassembly
- disassemble engine using correct procedures and shop practices
- evaluate engine components for serviceability
- assemble a diesel engine using proper procedures and serviceable components
- evaluate engines after assembly and inspect for potential faults
- evaluate operating engine for faults
- repair defects

#### **NOA topics covered in this section of training:**

### **B-5 Diagnoses engine and engine support systems**

#### B-5.01 Diagnoses base engine

- select and use on-board diagnostic tools such as scan tool, compression testers and measuring devices
- perform tests such as cylinder leak-down, compression and vacuum

- identify and distinguish sources of noises, vibrations and harshness (NVH) in engine components such as valve train, pistons and crankshaft
- remove and disassemble components to identify problem
- recognize worn, damaged and defective components such as worn camshafts, bearings and rings
- inspect valve timing and adjustment
- take measurements of base engine components and compare to manufacturers' specifications
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### B-5.02 Diagnoses lubrication systems

- select and use diagnostics tools such as flow meters, pressure gauges, temperature gauges and onboard diagnostic tools
- identify type of lubricant to be used according to manufacturers' specifications and operating conditions
- perform sensory inspections to identify symptoms such as leaks and damaged or worn components
- remove and disassemble components to identify problem
- take oil sample and interpret test results such as contamination, wear elements and trends
- test system pressure according to manufacturers' specifications to locate faults such as blockages, leakages and worn parts
- identify components of lubrication systems such as oil pump, regulator and pressure relief valve
- inspect lubrication system components for wear, damage and defects
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### B-5.03 Diagnoses cooling systems

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

#### B-5.04 Diagnoses intake and exhaust systems

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

#### B-5.06 Diagnoses engine control systems

- select and use diagnostic tools
- identify engine control systems types such as mechanical or electrical
- identify spark ignition system components

- perform visual and auditory inspections to identify defects such as throttle linkage wear and linkage binding
  - remove and disassemble components to identify problem
  - review ECM diagnostic information such as fault codes, parameters and software version
  - perform engine control system tests such as solenoid test, calibration test and injector cut-out test
  - interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications
  - perform starting aid tests such as glow plug, intake heater, block heater or ether injection
- B-5.07 Diagnoses emission control systems**
- identify equipment's type of emission system and components
  - remove and disassemble components to identify problem
  - test exhaust gas to determine emission compliance according to regulations
  - test components of emission control system such as sensors, EGR valve, PCV, diesel particulate filter and selective catalytic reduction (SCR) according to manufacturers' specifications
  - perform visual and auditory inspections to identify symptoms such as excessive smoke and damaged components
  - select and use on-board diagnostic tools such as gas analyser, computer and multimeters
  - interpret and analyze results of tests and inspections to determine required repair according to manufacturers' specifications

## **B-6 Repairs engine and engine support systems**

### **B-6.01 Repairs base engines**

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

### **B-6.02 Repairs lubrication systems**

- select and use repair tools and equipment such as feeler gauge, oil pressure gauge and measuring tools
- remove, disassemble and inspect lubrication system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service components according to manufacturers' procedures and specifications
- reassemble lubrication system components and perform measurements
- identify and select specified lubricants
- perform maintenance procedures such as changing oil and filter
- perform priming and pre-lubrication of oil pressure system
- complete repair by verifying system's function and performance

#### B-6.03 Repairs cooling systems

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

#### B-6.04 Repairs intake and exhaust systems

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

#### B-6.06 Repairs engine control systems

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

#### B-6.07 Repairs emission control systems

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



## **Powershift Transmissions – Theory**

**26 hours**

- describe operation of fluid couplers and torque convertors
- describe various transmission hydraulic circuits
- describe the operation of various types of powershift and automatic transmissions
- describe the operation of transfer cases
- describe the operation of hydraulic retarders

## **Powershift Transmissions – Shop**

**34 hours**

- evaluate torque convertors
- utilize hydraulic schematics
- evaluate powershift and automatic transmissions
- evaluate transfer cases
- evaluate hydraulic retarders
- repair faults

### **NOA topics covered in this section of training:**

#### **C-7 Diagnoses hydraulic, hydrostatic and pneumatic systems**

##### **C-7.01 Diagnoses hydraulic systems**

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

##### **C-7.02 Diagnoses hydrostatic systems**

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

##### **C-7.03 Diagnoses pneumatic systems**

- select and use diagnostic tools such as pressure gauges and multimeter
- locate components and perform tests such as cycle time, pressure and leak test

- perform visual and auditory inspection to identify problems such as leaks, contamination and heat
- compare equipment operation to manufacturers' specifications to verify complaint and expected performance
- remove and disassemble component to identify problem
- recognize worn, damaged and defective components such as compressors, air motors and control valves
- take measurements of the pneumatic system components and compare to manufacturers' specifications
- depressurize and repressurize pneumatic system according to manufacturers' specifications
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

## **C-8 Repairs hydraulic, hydrostatic and pneumatic systems**

### **C-8.01 Repairs hydraulic systems**

- select and use repair tools and equipment such as hand tools and shop tools
- remove, disassemble and inspect hydraulic system components for conditions such as scoring, wear patterns and heat discoloration
- flush hydraulic system as required according to manufacturers' specifications
- inspect and service accumulators
- select repair parts and materials such as motors, pumps and cylinders according to repair requirements and manufacturers' specifications
- depressurize hydraulic system as per manufacturers' specifications and government regulations
- remove, replace or recondition the serviced components according to manufacturers' procedures and specifications
- reassemble hydraulic system components and perform measurements
- torque components according to sequence and specifications
- assemble and install components according to manufacturers' specifications and procedures
- adjust and calibrate hydraulic system components and parts to manufacturers' specifications
- perform pre-lubrication, bleeding and priming procedures
- perform start-up and break-in according to manufacturers' specifications and procedures

### **C-8.02 Repairs hydrostatic systems**

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



### C-8.03 Repairs pneumatic systems

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

### D-9 Diagnoses drivetrain systems

#### D-9.01 Diagnoses clutch systems

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

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

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

#### D-9.03 Diagnoses driveline systems

- identify types of driveline systems and their operation
- perform sensory inspections to identify symptoms such as vibration, abnormal noise and excessive heat
- remove and disassemble components to identify problem
- inspect components for wear, damage and defects
- perform functionality tests according to manufacturers' specifications

- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications
- D-9.04 Diagnoses transmission and transfer case systems
- select and use diagnostic tools such as pressure gauge, computer and multimeter
  - identify types of transmission and transfer case systems such as manual, automatic, power shift and direct drive and their operation
  - check fluid level and condition
  - perform visual and auditory inspections to identify symptoms such as vibration, abnormal noise, leaks and excessive heat
  - remove and disassemble components to identify problem
  - perform diagnostic and functional tests according to manufacturers' specifications and procedures
  - interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications
- D-9.05 Diagnoses axle and differential systems
- select and use diagnostic tools such as temperature gauge and dial indicator
  - identify types of axle and differential systems and their operation
  - check fluid level and condition
  - perform sensory inspections to identify symptoms such as external leaks, abnormal noise and excessive heat
  - remove and disassemble components to identify problem
  - inspect axle and differential components in accordance with manufacturers' specifications and inspection procedures
  - perform diagnostic and functional tests according to manufacturers' specifications
  - interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications
- D-9.06 Diagnoses final drive systems
- select and use diagnostic tools such as temperature gauge and dial indicator
  - identify types of final drive systems and their operation
  - check fluid level and condition
  - perform visual and auditory inspections to identify symptoms such as leaks, noise and excessive heat
  - remove and disassemble components to identify problem
  - perform diagnostic and functional tests according to manufacturers' specifications
  - interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

## **D-10 Repairs drivetrain systems**

### **D-10.01 Repairs clutch systems**

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

### **D-10.02 Repairs torque converters, fluid couplers and retarders**

- select and use repair tools and equipment such as micrometer, feeler gauge and pullers
- remove, disassemble and inspect torque converter, fluid coupler and retarder components for conditions such as damage and wear

- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service components according to manufacturers' procedures and specifications
- reassemble torque converter, fluid coupler and retarder components and perform adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.03 Repairs driveline systems

- select and use repair tools and equipment such as pullers, torque wrench and press
- remove, disassemble and inspect driveline system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service components according to manufacturers' procedures and specifications
- reassemble driveline components and perform adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.04 Repairs transmission and transfer case systems

- select and use repair tools and equipment such as pullers, torque wrench and press
- remove, disassemble and inspect transmission and transfer case system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service components according to manufacturers' procedures and specifications
- reassemble transmission and transfer case components and perform calibration and adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.05 Repairs axle and differential systems

- select and use repair tools and equipment such as pullers, torque wrench and press
- remove, disassemble and inspect axle and differential system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service axle and differential components according to manufacturers' procedures and specifications
- reassemble components and perform adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.06 Repairs final drive systems

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

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**Level Three topics that are taught in context:**

*Common Occupational Skills*

*Routine Trade Activities*

*Operator Station Components*

*For details regarding the In Context Topic, see page 62*

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## Level Four

8 weeks

240 hours

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### Drivetrains – Theory

12 hours

- describe the operation of a hybrid drive system
- describe the operating principles of an automated manual transmission
- describe electronic controls related to automated shift technology

### Drivetrains – Shop

18 hours

- evaluate hybrid drive systems
- evaluate automated manual transmissions
- diagnose electronic faults

### NOA topics covered in this section of training:

#### D-9 Diagnoses drivetrain systems

##### D-9.01 Diagnoses clutch systems

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

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

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

##### D-9.03 Diagnoses driveline systems

- identify types of driveline systems and their operation
- perform sensory inspections to identify symptoms such as vibration, abnormal noise and excessive heat
- remove and disassemble components to identify problem
- inspect components for wear, damage and defects
- perform functionality tests according to manufacturers' specifications
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### D-9.04 Diagnoses transmission and transfer case systems

- select and use diagnostic tools such as pressure gauge, computer and multimeter
- identify types of transmission and transfer case systems such as manual, automatic, power shift and direct drive and their operation
- check fluid level and condition

- perform visual and auditory inspections to identify symptoms such as vibration, abnormal noise, leaks and excessive heat
- remove and disassemble components to identify problem
- perform diagnostic and functional tests according to manufacturers' specifications and procedures
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### D-9.05 Diagnoses axle and differential systems

- select and use diagnostic tools such as temperature gauge and dial indicator
- identify types of axle and differential systems and their operation
- check fluid level and condition
- perform sensory inspections to identify symptoms such as external leaks, abnormal noise and excessive heat
- remove and disassemble components to identify problem
- inspect axle and differential components in accordance with manufacturers' specifications and inspection procedures
- perform diagnostic and functional tests according to manufacturers' specifications
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

#### D-9.06 Diagnoses final drive systems

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

### D-10 Repairs drivetrain systems

#### D-10.01 Repairs clutch systems

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

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

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

#### D-10.03 Repairs driveline systems

- select and use repair tools and equipment such as pullers, torque wrench and press
- remove, disassemble and inspect driveline system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service components according to manufacturers' procedures and specifications
- reassemble driveline components and perform adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.04 Repairs transmission and transfer case systems

- select and use repair tools and equipment such as pullers, torque wrench and press
- remove, disassemble and inspect transmission and transfer case system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service components according to manufacturers' procedures and specifications
- reassemble transmission and transfer case components and perform calibration and adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.05 Repairs axle and differential systems

- select and use repair tools and equipment such as pullers, torque wrench and press
- remove, disassemble and inspect axle and differential system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- replace, recondition or service axle and differential components according to manufacturers' procedures and specifications
- reassemble components and perform adjustments
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

#### D-10.06 Repairs final drive systems

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

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### Electrical – Theory

**40 hours**

- apply scientific principles to explain electrical theory and magnetism
- identify electrical circuit types and faults utilizing test equipment
- explain the function and operation of a lead-acid battery
- explain the operation of cranking system and related components
- explain the operation of alternating current (AC) charging systems and related components

- explain common electrical and electronic components and their applications
- interpret wiring diagrams
- describe operation of electrical accessories and engine control circuits
- describe basic computer components using correct terminology
- explain operation of various electronic control systems and related components

## **Electrical – Shop**

**50 hours**

- diagnose electrical faults
- evaluate a lead acid battery
- evaluate an alternating current (AC) charging system and related components
- evaluate a cranking system and related components
- utilize wiring diagrams for fault diagnosis
- troubleshoot the accessory systems and engine control circuits
- operate various electronic control systems to check for proper function
- utilize diagnostic equipment
- repair defects

### **NOA topics covered in this section of training:**

#### **F-13 Diagnoses electrical systems**

##### **F-13.01 Diagnoses starting/charging systems and batteries**

- select and use diagnostic tools and equipment such as amperage/voltage/resistance (AVR) meter, multimeter and circuit tester
- inspect components and accessories such as capacitors, breakers and switches for signs of wear, damage or failure
- perform boosting, charging and load testing of battery and battery systems
- perform and interpret hydrometer test
- interpret and follow wiring schematics and diagrams
- perform starting/charging system and battery tests such as AVR, voltage drop and parasitic draw
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications

##### **F-13.02 Diagnoses electrical components, motors and accessories**

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

#### **F-14 Repairs electrical systems**

##### **F-14.01 Repairs starting/charging systems and batteries**

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



#### F-14.02 Repairs electrical components, motors and accessories

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

### **F-15 Diagnoses electronic vehicle management systems**

#### F-15.01 Reads diagnostic trouble codes (DTCs)

- 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
- perform functional tests to find active and intermittent codes
- refer to manufacturers' diagnostic sequence for code definition

#### F-15.02 monitors parameters

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

#### F-15.03 Interprets test results

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

#### F-15.04 Tests system circuitry and components

- 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
- determine faulty circuitry and/or components

### **F-16 Repairs electronic vehicle management systems**

#### F-16.01 Updates component software

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

#### F-16.02 Repairs components

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

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## **Environmental Control Systems – Theory**

**12 hours**

- describe the operation of heating, ventilation and air conditioning systems
- identify various heating and air conditioning components
- describe proper usage of test equipment

## Environmental Control Systems – Shop

18 hours

- demonstrate service procedures
- repair air conditioning and heating components
- repair air conditioning systems

### NOA topics covered in this section of training:

#### G-17 Diagnoses environmental control systems

##### G-17.01 Diagnoses heating systems

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

##### G-17.02 Diagnoses ventilation and filtration systems

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

##### G-17.03 Diagnoses air conditioning systems

- select and use diagnostic tools and equipment such as multimeter, circuit tester, A/C gauges, A/C recovery/recycling unit and black lights
- locate components and perform tests such as refrigerant pressure tests, air flow tests, voltage tests and resistance tests
- perform visual and auditory inspection to verify customer complaint such as noises and odours to guide the diagnostic process
- compare equipment operation to expected performance
- recognize worn, damaged and defective components such as condensers, evaporators, hoses and seals
- interpret and follow wiring diagrams and air flow schematics
- interpret viewed values and codes to determine condition of systems, components and accessories
- activate system self-diagnosis function to retrieve trouble codes
- remove and disassemble components to identify problem

- check electronically-controlled system operation for conditions such as blown fuses, seized motors and broken wires
- identify compatibility of refrigerant with systems, tools and seals
- pressurize systems with nitrogen to locate leaks according to manufacturers' specifications and government regulations
- interpret and analyze results of functional tests and inspections to determine required repair according to manufacturers' specifications or expected performance

#### G-17.04 Diagnoses sound suppression systems

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

### **G-18 Repairs environmental control systems**

#### G-18.01 Repairs heating systems

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

#### G-18.02 Repairs ventilation and filtration systems

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

#### G-18.03 Repairs air conditioning systems

- select and use repair tools and equipment to evacuate and recharge system and to identify types of refrigerant

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

#### G-18.04 Repairs sound suppression systems

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

### Fuel Systems – Theory

**40 hours**

- describe preventive maintenance procedures for diesel fuel storage and delivery systems
- describe proper procedures to diagnose faults in fuel delivery and control systems
- describe proper procedures to inspect, adjust or repair fuel delivery and control systems
- describe the procedures involved in performance testing on diesel engines

### Fuel Systems – Shop

**50 hours**

- perform preventative maintenance
- evaluate diesel injection delivery and control components
- evaluate an operating diesel engine
- conduct performance testing
- repair faults

#### NOA topics covered in this section of training:

#### B-5 Diagnoses engine and engine support systems

##### B-5.05 Diagnoses fuel systems

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

##### B-5.06 Diagnoses engine control systems

- select and use diagnostic tools

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

#### B-5.07 Diagnoses emission control systems

- identify equipment's type of emission system and components
- remove and disassemble components to identify problem
- test exhaust gas to determine emission compliance according to regulations
- test components of emission control system such as sensors, EGR valve, PCV, diesel particulate filter and selective catalytic reduction (SCR) according to manufacturers' specifications
- perform visual and auditory inspections to identify symptoms such as excessive smoke and damaged components
- select and use on-board diagnostic tools such as gas analyser, computer and multimeters
- interpret and analyze results of tests and inspections to determine required repair according to manufacturers' specifications

### **B-6 Repairs engine and engine support systems**

#### B-6.05 Repairs fuel systems

- select and use repair tools and equipment such as fuel pressure gauge, hand tools, and fuel transfer and storage equipment
- remove, disassemble and inspect fuel system components such as fuel lines and manifolds for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants, o-rings and fastening devices according to repair requirements and manufacturers' specifications
- clean and repair or replace fuel system components such as fuel filters, governors, pumps, common rail fuel components and injectors
- reassemble fuel system components and perform measurements
- torque components according to sequence and specifications
- pressurize and bleed system
- perform fuel system timing procedures
- complete repair by verifying system's function and performance

#### B-6.06 Repairs engine control systems

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

#### B-6.07 Repairs emission control systems

- select and use diagnostic tools and equipment such as scan tool and exhaust gas analysers

- remove, disassemble and inspect emission control system components for conditions such as damage and wear
- select repair parts and materials such as gaskets, sealants and fastening devices according to repair requirements and manufacturers' specifications
- repair or replace emission system components such as heaters, injectors, sensors, EGR valves, PVC and DPF filters
- reassemble emission system components and calibrate
- complete repair by verifying system's function and performance according to manufacturers' specifications and government regulations

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**Level Four topics that are taught in context:**

***Common Occupational Skills***

***Tools and Equipment***

***Routine Trade Activities***

***Operator Station Components***

***For details regarding the In Context Topic, see page 62***



# IN CONTEXT TOPICS

Some material may be taught 'in context.' In context means learning that has already taken place and is being applied to the applicable task. Learning outcomes for in context topics are accomplished in other topics in that level.

## **A-1 Uses and maintains tools and equipment**

### A-1.01 Maintains tools and equipment

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

### A-1.03 Operates access equipment

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

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

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

## **A-2 Performs general maintenance and inspections**

### A-2.01 Maintains fluids

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

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

- identify types, sizes and grades of fasteners, sealing devices, adhesives and gaskets
- chase threads and repair with tap and dies
- remove broken fasteners using methods such as drilling, heating and welding
- install thread inserts to create original bolt size
- select types of threads such as coarse and fine used for different applications
- torque fasteners to manufacturers' specified torque rating
- prepare surfaces to receive sealing devices, adhesives and gaskets according to manufacturers' specifications

- select and apply sealing compounds to lock fasteners
  - select and apply sealing compounds to seal, to repair imperfections or to aid gaskets
  - identify types of gaskets such as pre-formed composite gaskets, paper, cork-rubber and metal
  - make gaskets according to task requirements
  - install gaskets according to manufacturers' specifications in order to ensure tight seal and prevent damage to the gasket
- A-2.03 Services hoses, tubing, piping and fittings
- identify ratings and applications of hoses, tubing, piping and fittings
  - identify types of fittings such as reusable and crimp
  - crimp fittings using crimping tools and dies
  - bend and flare tubing and piping using hand and power tools
  - perform preventative maintenance of hoses, tubing, piping and fittings by checking for deficiencies such as chafed hoses, bubbling and leaks
  - remove and replace hoses, tubing, piping and fittings
  - fabricate hoses, tubing and piping to specifications by cutting to length, cleaning interior and verifying the crimp of fittings
- A-2.04 Services bearings and seals
- select and use tools and equipment such as hydraulic presses, heating equipment, cooling equipment, and seal and bearing drivers
  - remove and install bearings
  - remove and install seals such as front and rear main seals, cam shaft seals and accessory drive seals
  - lubricate bearings and seals as required by manufacturers' specifications
  - inspect bearings and seals for leaks, stiffness and wear
  - identify types of seals for the task such as lip seals and dual cone
  - renew shaft using wear sleeve to repair seal surface area
  - set up bearing according to manufacturers' specifications such as pre-load and end play
- A-2.05 Services safety features
- perform function test and maintenance of safety features such as restraints and warning devices
  - report defects of safety features in order to ensure the defects are corrected
  - recognize criteria for repair or replacement of safety features
  - repair safety features according to manufacturers' and government specifications
  - remove and replace safety features according to manufacturers' and government specifications
  - adjust safety features according to operating manufacturers' specifications and government regulations
- A-2.06 Performs scheduled maintenance procedures
- follow manufacturers' and company guidelines for scheduled maintenance
  - record deficiencies with equipment in order to arrange for repair
  - determine working condition and operating environment of equipment and adjust regular maintenance accordingly
  - refer to previous maintenance records for maintenance and repair history
  - consult with equipment operator or owner and refer to operator records for maintenance and repair requirements
  - verify maintenance and repair
  - maintain service records
- A-2.07 Identifies operational faults
- verify complaints with operating equipment
  - determine abnormal operating characteristics such as squealing, knocking and vibrations
  - interpret source and cause of abnormal operating characteristics
  - select and use diagnostic and testing tools and equipment such as scanners, gauges and onboard diagnostic equipment
  - record deficiencies with equipment in order to arrange for repair



A-2.08 Performs operational check-out

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

**A-3 Organizes work**

A-3.01 Uses documentation and reference materials

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

A-3.02 Completes documentation

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

A-3.03 Communicates with others

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

A-3.04 Prepares job action plan

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

A-3.05 Maintains safe work environment

- keep work area clean
- use lock-out and tag-out procedures to prevent unwanted or unsafe operation of equipment
- use anti-spill kits and procedures
- apply local, provincial and national safety regulations such as WHMIS and TDG
- recognize worksite hazards that require the use of PPE and safety equipment
- recognize potential hazards such as noise level, air quality, and flammable and explosive materials
- report hazardous conditions and work practices to prevent workplace injuries
- clean, handle, store, remove and dispose of hazardous materials such as batteries and waste products according to jurisdictional regulations
- perform safety inspection of equipment and surrounding work area

- ensure all equipment is stored, parked on leveled ground and attachments lowered
- communicate work-related information such as tagging out and noting work in progress

#### **A-4 Performs routine trade activities**

##### **A-4.01 Heats materials**

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

##### **A-4.02 Cools materials**

- use component cooling methods such as using water, CO2 and liquid nitrogen
- determine required cooling of materials according to manufacturers' specifications
- measure cooling of metals using methods such as using a heat stick, using infrared temperature gun and measuring with temperature probe

##### **A-4.03 Cuts materials**

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

##### **A-4.04 Welds materials**

- select and use welding tools and equipment such as torches, metal inert gas (MIG) welders, and shielded metal arc welding (SMAW) equipment
- prepare work environment and material to be welded
- recognize jurisdictional limitations, certification and licensing requirements for different types of welding
- select welding material as required by the task
- recognize limitations in work environment such as gases, enclosed spaces and other personnel
- determine composition and function of material to be welded
- isolate all electronics on equipment by disconnecting ground source or using surge protector to prevent damage
- isolate component to be welded, place ground as close to weld as possible to avoid unwanted arcing and heating through components such as bearings, bushings, cylinders and seals
- recognize manufacturers' prohibition of welding components such as ROPS, FOPS and OPS

##### **A-4.05 Cleans parts and materials**

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

#### **Operator Station Components**

#### **H-19 Diagnoses structural components, accessories and attachments**

##### **H-19.02 Diagnoses operator station components**

- select and use diagnostic tools such as decibel meter, diagnostic software and multimeter
- locate components and perform operational tests of components, accessories and attachments
- perform sensory inspection to identify problems such as cracks, leaks and defects

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

## **H-20 Repairs structural components, accessories and attachments**

### H-20.02 Repairs operator station components

- select and use repair tools and equipment such as multimeter, hand tools, shop tools, oxyacetylene torches and welding equipment
- remove and disassemble defective and worn components according to manufacturers' specifications and procedures
- select repair parts and materials according to repair requirements and manufacturers' specifications
- replace, recondition, service and reassemble components according to manufacturers' specifications and procedures
- adjust operator station components such as controls and sensors to manufacturers' specifications
- complete repair by verifying system's function, operation and performance according to manufacturers' specifications and government regulations

# APPENDIX A: POST HARMONIZATION TRAINING PROFILE CHART

This chart which outlines the finalized model for SATCC technical training sequencing with a cross reference to the Harmonized apprenticeship technical training sequencing, at the topic level.

Implementation for harmonization was implemented progressively. Level one was implemented in 2017/2018, level two 2018/2019, level three 2019/2020, and level four in 2020/2021.

| SATCC Level One                       | Transcript Code   | Hours | Pan-Canadian Harmonized Level One  |
|---------------------------------------|-------------------|-------|------------------------------------|
| *                                     | *                 | *     | *                                  |
| Basic Tools                           | TOOL 145 – Theory | 12    | Tools and Equipment                |
|                                       |                   |       | Communication Techniques           |
|                                       | TOOL 146 – Shop   | 12    | Routine Work Practices             |
|                                       |                   |       | Common Occupational Skills         |
| Brake Systems                         | BRAK 111 – Theory | 24    | Brake Systems                      |
|                                       | BRAK 112 – Shop   | 36    | Wheel Assemblies                   |
| Electrical                            | ELCT 100 – Theory | 14    | Charging Systems                   |
|                                       |                   |       | Starting Systems                   |
|                                       | ELCT 101 – Shop   | 16    | Battery Systems                    |
|                                       |                   |       | Electrical Components              |
| Environmental Control Systems         | HVAC 100          | 6     | Heating Systems                    |
|                                       |                   |       | Ventilation and Filtration Systems |
|                                       |                   |       | Air Conditioning Systems           |
| Hydraulics                            | HYDR 108 – Theory | 24    | Hydraulic Systems                  |
|                                       | HYDR 109 – Shop   | 36    | Pneumatic Systems                  |
| Steering Systems                      | STER 100 – Theory | 12    | Steering Systems                   |
|                                       | STER 101 – Shop   | 18    | Suspension Systems                 |
| Structural Components and Accessories | MAIN 100 – Theory | 12    | Undercarriage Systems              |
|                                       |                   |       | Operator Station Components        |
|                                       | MAIN 101 – Shop   | 18    | Sound Suppression Systems          |
|                                       |                   |       | Structural Components              |
|                                       |                   | 240   |                                    |

| SATCC Level Two                          | Transcript Code    | Hours | Pan-Canadian Harmonized Level Two  |
|--|--------------------|-------|--|
| <i>*in context</i>                       | <i>*in context</i> |       | * Common Occupational Skills   |
|  |                    |       | * Tools and Equipment  |
|  |                    |       | * Routine Work Activities  |
|  |                    |       | * Operator Station Components  |
| Braking Systems ABS                      | BRAK 206 – Theory  | 14    | Brakes Systems   |
|  | BRAK 207 – Shop    | 16    | Wheel Assemblies   |
| Drivetrain Systems                       | DRTR 201 – Theory  | 24    | * (EXCEED) – Content covered in this course is reviewed in TRNM 306/307 – POWERSHIFT TRANSMISSIONS Level 3 |
|  | DRTR 202 – Shop    | 36    |  |
| Electrical                               | ELCT 202 – Theory  | 12    | Equipment Management Systems and Electronic Components   |
|  | ELCT 203 – Shop    | 18    |  |
| Hydraulics                               | HYDR 204 – Theory  | 30    | Hydrostatics   |
|  |                    |       | Pneumatics   |
|  | HYDR 205 – Shop    | 30    | Hydraulics   |
| Steering and Directional Control Systems | STER 202 – Theory  | 12    | Steering Systems   |
|  | STER 203 – Shop    | 18    | Suspension Systems   |
| Structural Components                    | MAIN 200 – Theory  | 12    | Structural Components  |
|  | MAIN 201 – Shop    | 18    |  |
|  |                    | 240   |  |

| SATCC Level Three   | Transcript Code          | Hours             | Pan-Canadian Harmonized Level Three    |
|---|--------------------------|-------------------|--|
| <i>*in context</i>  | <i>*in context</i>       |                   | * Common Occupational Skills           |
|   |                          |                   | * Routine Work Activities              |
|   |                          |                   | * Operator Station Components          |
| Alternative Fuels   | FUEL 302 – Theory        | 12                | Fuel Delivery Systems                  |
|   | FUEL 303 – Shop          | 18                |  |
| Electrical  | ELCT 301 – Theory        | 14                | Charging Systems                       |
|   | ELCT 302 – Shop          | 16                | Starting Systems                       |
| Electrical Components                                     |                          |                   |  |
| Engines and Engine Support Systems                        | ENGN 306 – Theory        | 55                | Base Engines                           |
|   |                          |                   | Lubrication Systems                    |
|   |                          |                   | Intake Systems                         |
|   |                          |                   | Exhaust Systems                        |
|   | ENGN 307 – Shop          | 65                | Engine Management Systems              |
|   |                          |                   | Emission Control Systems               |
|   |                          |                   | Cooling Systems                        |
|   |                          |                   | Hydraulic Systems                      |
|   |                          |                   | Hydrostatic Systems                    |
|   | Powershift Transmissions | TRNM 306 – Theory | 26                                     |
| Torque Converters, Fluid Couplers and Hydraulic Retarders |                          |                   |  |
| Manual Transmission and Transfer Cases                    |                          |                   |  |
| TRNM 307 – Shop   |                          | 34                | Automatic and Powershift Transmissions |
|   |                          |                   | Driveline Systems                      |
|   |                          |                   | Drive Axles and Differentials          |
|   |                          |                   | Final Drive Systems                    |
|   |                          | 240               |  |

| SATCC Level Four              | Transcript Code    | Hours | Pan-Canadian Harmonized Level Four  |
|-------------------------------|--------------------|-------|---|
| <i>*in context</i>            | <i>*in context</i> |       | * Common Occupational Skills  |
|                               |                    |       | * Tools and Equipment   |
|                               |                    |       | * Routine Work Activities   |
|                               |                    |       | * Operator Station Components   |
| Drivetrains                   | DRTR 400 – Theory  | 12    | Torque Converters, Fluid Couplers and Hydraulic Retarders<br>Automatic and Powershift Transmissions |
|                               | DRTR 401 – Shop    | 18    | Driveline Systems   |
|                               |                    |       | Drive Axles and Differentials   |
|                               |                    |       | Final Drive Systems   |
|                               |                    |       | Hydrostatic Systems   |
| Electrical                    | ELCT 400 – Theory  | 40    | Equipment Management Systems and Electronic Components  |
|                               | ELCT 401 – Shop    | 50    |   |
| Environmental Control Systems | HVAC 400 – Theory  | 12    | Heating Systems<br>Ventilation and Filtration Systems   |
|                               | HVAC 401 – Shop    | 18    | Air Conditioning Systems  |
| Fuel Systems                  | FUEL 404 – Theory  | 40    | Base Engines  |
|                               |                    |       | Lubrication Systems   |
|                               |                    |       | Intake Systems  |
|                               |                    |       | Exhaust Systems   |
|                               |                    |       | Fuel Delivery Systems   |
|                               | FUEL 405 – Shop    | 50    | Engine Management Systems   |
|                               |                    |       | Emission Control Systems  |
|                               |                    |       | Cooling Systems   |
|                               |                    |       | Hybrid Vehicles   |
|                               |                    |       | Electric Vehicles (EV)  |
|                               |                    | 240   |   |

### Exceed Topics

Throughout this guide to course content there are topics which exceed the minimum scope of work as set out in the Heavy Duty Equipment Technician NOA. Industry in Saskatchewan has deemed certain topics to fall within the scope of work of the Heavy Duty Equipment Technician trade in Saskatchewan and therefore require technical training to cover these topics.