THE REGISTERED APPRENTICESHIP OCCUPATIONS AND STANDARDS CENTER OF EXCELLENCE (AOSC)

Farm Equipment Mechanic and Technician
National Occupational Framework

ONET Code: 49-3041.00

RAPIDS Code: 0187

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Introduction to Using This Document

Under the Registered Apprenticeship Technical Assistance Centers of Excellence award, the Urban Institute leads the Occupations and Standards work. One of the main objectives of Urban's project is to create high-quality, well-researched, consensus-based work process schedules that are nonproprietary and widely available. This document is a product of that work and contains three sections: the occupational overview, the work process schedule, and the related technical instruction.

The **occupational overview** is a general introduction, including alternative job titles, any prerequisites, and, if applicable, the total number of hours needed to complete a time-based or hybrid program.

The **work process schedule** outlines the major job functions, competencies, and/or hours an apprentice completes in a registered apprenticeship program. It outlines what apprentices are expected to learn on the job with the support of a mentor or journeyworker (a worker mastering the competencies of an occupation in a particular industry), including both core competencies and those deemed optional by experts in the field. The work process schedule is the foundational document guiding a program.

Urban works with numerous experts to ensure the content is thoroughly researched and vetted to reflect the expectations of industry, educators, labor unions, employers, and others involved in apprenticeship for this occupation. Sponsors and employers can use the work process schedule as their program standards with assurances it has been approved by experts in the field.

The **related technical instruction** presents considerations for the coursework that apprentices will undertake to supplement on-the-job learning. It is intended to serve as a reference to sponsors exploring their options for the accompanying classroom, virtual, or hybrid training.

How to Use the Work Process Schedule

Sponsors can adapt the work process schedule to accommodate their needs for competency- or time-based or hybrid programs. In a **competency-based** apprenticeship, sponsors assess apprentices' progress across core and optional competencies listed in the work process schedule. In a **time-based** apprenticeship, apprentices complete a predetermined number of hours across major job functions and the program overall. In a **hybrid** apprenticeship, sponsors monitor apprentices' hours spent on major job functions and assess their proficiency across competencies.

Each program type has a different method of assessment:

- **For a competency-based program**, apprentices engage in activities and make progress toward proficiency in the identified competencies. Sponsors overseeing apprentices' work assess their mastery of the outlined competencies using the following rating scale:

  4—Competent/proficient (able to perform all elements of the task successfully and independently)

  3—Satisfactory performance (able to perform elements of the task with minimal assistance)

  2—Completed the task with significant assistance

  1—Unsuccessfully attempted the task

  0—No exposure (note the reason—absence, skill isn't covered, etc.)

  The competencies may be completed in any order. Apprentices must perform at a level 4 or 3 in all competencies listed as "core" to complete the apprenticeship program successfully.

- **For a time-based program,** sponsors monitor apprentices' completion of hours in training across major job functions. The total number of hours recommended for this occupation is listed in the occupational overview and is based on guidance from the US Department of Labor. Generally, apprentices must have at least 2,000 hours overall for on-the-job learning, but occupations of greater complexity may require more hours. Sponsors will provide apprentices with supervised work experience and allocate the total number of hours across the major job functions to adequately train their apprentices.

- **The hybrid approach** blends both competency- and time-based strategies. Sponsors measure apprentices' skills acquisition through a combination of completing the minimum number of hours of on-the-job learning successfully demonstrating identified competencies. Sponsors will assess apprentices' proficiencies as described for competency-based programs with a rating scale of 0–4 for every core competency. Generally, apprentices have at least 2,000 hours overall for on-the-job learning, but occupations of greater complexity may require more hours. Sponsors will document apprentices' completion within a minimum and maximum range of hours assigned for each major job function.

Farm Equipment Mechanic and Technician Occupational Overview

Occupational Purpose and Context

Farm equipment mechanics and technicians work at farms and farm equipment dealerships to diagnose, adjust, repair, or overhaul farm machinery and vehicles, such as tractors, harvesters, dairy equipment, and irrigation systems. They play a key role by keeping agricultural machinery operating efficiently and reliably, supporting farmers in maintaining their productivity and reducing equipment downtime.

Potential Job Titles

Agricultural mechanic, agricultural technician, farm equipment mechanic, farm equipment service technician, field technician, mechanic, service technician, tractor mechanic, tractor technician.

Apprenticeship Prerequisites

High school diploma or equivalent; basic math, reading, writing, and computer literacy skills.

Recommended Length of Apprenticeship (Time/Hybrid Programs Only)

The recommended length of on-the-job learning in a farm equipment mechanic and technician apprenticeship program is 4,000 to 6,000 hours.

Work Process Schedule

Farm Equipment Mechanic and Technician

ONET Code: 49-3041.0

RAPIDS Code: 0187

Instructions for Use:

Competency-based programs: In the "performance level achieved" column of the work process schedule (see examples starting on the next page), assess apprentices' performances on each competency with the scale below. No monitoring of hours is required for this approach. See "Guidelines for Competency-Based, Hybrid and Time-Based Apprenticeship Training Approaches," US Department of Labor, Employment and Training Administration, Office of Apprenticeship, October 20, 2015, https://www.apprenticeship.gov/sites/default/files/bulletins/Cir2016-01.pdf.

4—Competent/proficient (able to perform all elements of the task successfully and independently)

3—Satisfactory performance (able to perform elements of the task with minimal assistance)

2—Completed the task with significant assistance

1—Unsuccessfully attempted the task

0—No exposure (note the reason—absence, skill isn't covered, etc.)

Time-based programs: In the "hours" row, specify the number of hours apprentices will fulfill for each job function. No assessment of competencies is required for this approach.

Hybrid programs: In the "performance level achieved" column, assess apprentices' performances on each competency using the 0–4 scale above. In the "hours" row, identify a range of hours apprentices should spend working on each major job function.

Job Function 1: Operates in the workplace in a safe and effective manner		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Adheres to safety, health, environmental, and occupational regulations (such as those set by Occupational Safety and Health Administration, or OSHA)	Core	
B. Wears appropriate personal protective equipment (PPE) when performing equipment repairs and maintenance	Core	
C. Locates emergency supplies and equipment and checks to ensure proper working order, such as fire extinguishers, Material Safety Data Sheets (MSDS), and first aid supplies	Core	
D. Handles and properly disposes of all chemical and other bioproducts in accordance with MSDS guidelines	Core	
E. Locates, interprets, and properly stores documentation of equipment operation and maintenance	Core	
F. Ensures power sources are managed properly before, during, and after repairs and maintenance	Core	
G. Performs lockout–tagout safety procedures before any maintenance or service work is performed	Core	
H. Maintains a clean, orderly, foreign object damage (FOD)-free workspace	Core	

Job Function 2: Performs preventative maintenance checks and services		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Monitors equipment operations and verifies performance meets proper functioning requirements	Core	
B. Performs planned and unscheduled equipment maintenance procedures in accordance with the company-approved maintenance plan	Core	

C. Refers to service manuals or online databases to identify the mechanical specifications and standards for each piece of equipment	Core	
D. Services vehicles to manufacturer specifications	Core	
E. Performs equipment operations, including start-up, emergency, normal shutdown, and manual functions to effectively and safely meet production and maintenance requirements	Core	
F. Cleans and lubricates parts to maintain them in good working order	Core	
G. Flushes all systems using appropriate protocols before maintenance procedures and ensures fluids are at proper levels after the completion of maintenance	Core	
H. Changes oil and tests battery, following manufacturers' suggested timeline	Core	
I. Inspects brake, steering, wheel, and other systems to ensure they are in proper working condition	Core	
J. Communicates telematics diagnostics and data to equipment manufacturer	Core	

Job Function 3: Performs diagnostic procedures on equipment		
Hours **(time-based and hybrid programs only):**		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Confers with customers or users to assess the equipment's problem	Core	
B. Inspects mechanical equipment to locate damage, defects, or depreciation	Core	
C. Tests mechanical equipment, including test driving, to ensure proper functioning while adhering to all safety procedures	Core	
D. Attaches test instruments properly to equipment for testing	Core	
E. Examines equipment and reads inspection reports to locate and diagnose malfunctions	Core	
F. Writes work orders or descriptions of equipment problems to outline repairs or modifications needed	Core	

G. Develops a repair strategy based on shop and industry best practices and service manual	Core	

Job Function 4: Repairs and maintains electrical and electronic systems		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Uses Controller Area Network (CAN) bus technology to perform diagnostic tests on electrical wiring components	Core	
B. Tests analog, digital, and electronic components including wiring, using test meters	Core	
C. Researches a diagnosed problem to identify appropriate parts for use and mechanical specs to be met	Core	
D. Replaces worn or damaged electrical components and wiring using hand tools and soldering equipment	Core	
E. Repairs ignition systems, lights, and instrument panels	Core	
F. Reassembles machines and equipment following repair, tests machine operation, and adjusts machine and equipment as necessary to ensure optimal performance	Core	
G. Troubleshoots Artificial Intelligence (AI) components of equipment	Optional	

Job Function 5: Repairs and maintains engines		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Tunes engine to ensure proper functioning in accordance with the suggested timeline by the manufacturer	Core	
B. Dismantles defective machines for repair, utilizing proper tools	Core	
C. Repairs or replaces defective engines or engine components	Core	

D. Uses appropriate tools and measurement techniques to determine that components or assemblies are within factory specifications.	Core	
E. Troubleshoots fuel injection system	Core	
F. Reassembles engine components following repair using proper torque specifications; tests operation and adjusts the engine as necessary to ensure optimal performance	Core	

Job Function 6: Repairs and maintains hydraulic systems		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Flushes hydraulic system using appropriate protocol for disposing of fluids and refills fluids to manufacturer specifications	Core	
B. Repairs and replaces hydraulic system components in accordance with schematics	Core	
C. Ensures correct harness and hose routing and securement	Core	
D. Reassembles hydraulic system components following repairs, test operation, and adjusts as necessary to ensure optimal performance	Core	

Job Function 7: Repairs and maintains farm equipment's Heating, Ventilation, and Air Conditioning (HVAC) systems		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Troubleshoots and runs diagnostics on HVAC systems	Core	
B. Follows industry standards, such as those set by OSHA and the Environmental Protection Agency (EPA), for installation, maintenance, and repair of HVAC systems	Core	
C. Assembles and installs pipe systems, gauges, and related equipment within HVAC systems	Core	

D. Interprets technical information such as temperature and pressure data, diagrams, and schematics to ensure proper functioning	Core	
E. Reassembles HVAC system components following repairs, tests the equipment's operations, and adjusts it as necessary to ensure optimal performance	Core	

Job Function 8: Repairs and maintains powertrain systems		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Disassemble powertrain systems for repair and maintenance	Core	
B. Reconditions powertrain system by cleaning and lubricating equipment for optimal performance, including pistons, bearings, gears, and valves	Core	
C. Replaces damaged or worn parts to meet manufacturers' specifications and suggested maintenance timelines	Core	
E. Reassembles machines and equipment after repair of powertrain systems, tests its operation, and makes adjustments as needed	Core	
F. Performs thorough inspections and measurements that ensure the repairs meet factory specifications	Core	

Job Function 9: Uses machinery and vehicles for transportation of equipment during repairs		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Moves large objects using heavy equipment	Core	
B. Drives trucks, cranes, or forklifts to haul tools and equipment for onsite repairs of large machinery	Core	
C. Uses hoists to lift or position large machinery for repair	Core	

D. Secures heavy equipment for transportation and repair using proper mechanisms (i.e., capacity load chains and blocks)	Core	
E. Regularly inspects transportation machinery for safety and proper operation	Core	
F. Maintains proper certifications for the use of transportation equipment	Core	

Job Function 10: Performs clerical recordkeeping tasks		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Uses a computer to track repair and maintenance by recording repairs made and parts used	Core	
B. Uses equipment manual specifications to identify and order the correct part to be delivered for repairs	Core	
C. Records, tracks, and monitors personal labor hours	Core	
D. Provides a complete work order to the appropriate department in a timely manner for recording and processing	Core	

Job Function 11: Demonstrates professionalism and customer service skills		
Hours (time-based and hybrid programs only):		
Competencies	**Core or optional**	**Performance level achieved (0–4)** (competency-based and hybrid programs only)
A. Demonstrates professionalism and confident communication etiquette when interacting with colleagues and customers, including responding in a timely manner and providing accurate and complete information	Core	
B. Speaks with colleagues and customers to provide a complete and accurate explanation of repairs needed	Core	
C. Effectively manages time on tasks, monitoring, and tracking deadlines	Core	

D. Complies with and demonstrates an understanding of company policies about diversity, equity, and inclusion	Core	
E. Identifies challenges and develops solutions for addressing them independently and with assistance from supervisors, as needed	Core	
F. Leverages principles of effective communication to work within a team environment and between departments	Core	

Related Technical Instruction

FARM EQUIPMENT MECHANIC & TECHNICIAN **ONET Code: 49-3041.00**

RAPIDS Code: 0187

Instructions for Use:

Registered Apprenticeships must include at least 144 hours of Related Technical Instruction (RTI). Courses offered by accredited colleges and universities may be assigned a credit hour determination rather than a contact hour determination. In general, an academic credit unit is the equivalent of 15 clock hours of instruction.

Development and Use of this RTI Outline: Employers and academic institutions may approach RTI in markedly different ways. Our goal was not to identify the single best way to provide RTI, or to identify a single provider whose content we deemed to be superior. That said, in the case of this occupation, we relied heavily on the work already accomplished by the National Council for Agricultural Education (NCAE) through their Curriculum for Agricultural Science Education (CASE) initiative, in which a group of educators and industry leaders worked collaboratively to develop a consensus-based curriculum for Agricultural Equipment Maintenance & Technology (AEMT). The National Science Foundation supported the development of this curriculum. It was led by CASE and AgCentric at Central Lakes College, Northland Community and Technical College, Ridgewater College, the Minnesota State Northern Agricultural Center of Excellence, and many industry partners. CASE provides support to those who seek to provide education and training in this field (https://www.case4learning.org/curriculum/technical-applications-in-agriculture-taa/).

Licensure or certification requirements: None
Degree requirements for licensure or certification, if applicable: None
Accreditation requirements of instructional provider for licensure or certification, if applicable: Not applicable
Anticipated changes in licensure or certification requirements, if known: None
Examples of state licensure or certification requirements: Not applicable

Examples of RTI providers for this occupation
Professional associations and labor organizations: The Association for Equipment Distributers Foundation provides training and certification for various occupations within the equipment industry, including technicians (https://aednet.org/continuing-education/certifications). Curriculum for Agricultural Science Education (CASE), an initiative of the National Council for Agricultural Education, provides professional development opportunities for agricultural science and production teachers, as well as curricular outlines and materials that can be used to educate students and help prepare for the Association of Equipment Distributors certification exam (https://www.case4learning.org/about-case/mission-vision-and-values/). **Military:** We are unaware if the US military service branches offer civilians or contractors education or training relevant to this occupation. **States/municipalities:** Many states host agricultural extension centers at public, land-grant colleges and universities, which provide education and agricultural support services to those involved in agriculture production. **Federal Agencies:** In partnership with states and local governments, the US Department of Agriculture's National Institute for Food and Agriculture supports the Cooperative Extension System (CES) to help advance agricultural knowledge and practice (https://www.nifa.usda.gov/about-nifa/how-we-work/extension/cooperative-extension-system). **Colleges and universities:** Many community colleges serve agriculturally crucial areas and offer certificate and degree programs in agricultural equipment maintenance and repair. **No-cost online providers:** Not applicable **Continuing education or specialty education providers:** Some equipment manufacturers and distributors provide education and training for those servicing and repairing their equipment. In addition, some large equipment manufacturers maintain their education programs and facilities to advance education and training relevant to their trade. For example, Caterpillar University provides free training for technicians through the Technicians for North America (T4NA) program (www.holtcat.com/news/articletype/articleview/articleid/249 www.caterpillar.com/en/careers/career-areas/dealer-technician/thinkbig.html).

*Courses flagged with an asterisk in the title indicate that the learning objectives were derived from the Course Content outlines and AED Standard Alignment CASE AEMT list made available by CASE4Learning: www.case4learning.org/curriculum/technical-applications-in-agriculture-taa/

Working in the Agriculture and Agroscience Industry

(based largely on the Introduction to Agriculture, Food and Natural Resources course outline provided by the Curriculum for Agricultural Science Education initiative)

Hours: 20

Sample learning objectives

- Explain the role of agriscience in food production and resource conservation.
- Explain the function and importance of the agricultural commodities market and discuss what types of commodities form the basis of the US agricultural system and the impact of the commodities market on food prices.
- Discuss the types of occupations critical to agriculture science and production and the pathways individuals take to those occupations.
- Demonstrate the ability to maintain accurate records and share information accurately, concisely, and appropriately with others in the agriculture and agriscience industries.
- Explain the main safety concerns that individuals in the agriculture field, as well as those who work with mechanical equipment, must address, as well as the ways that individuals can protect themselves against those safety risks.
- List the types of matter found in soil and the proportions in which each is found in various types of soil. Describe the ways in which soil is evaluated for its suitability to support agricultural production and effective strategies for preventing soil erosion.
- Describe the water cycle, natural and human factors that impact the cycle, and the properties of water that make it suitable for human consumption and agricultural and industrial use. Discuss the sources and impact of water pollution as well as strategies for reducing water pollution. Discuss ways in which farms access, store and utilize water, as well as challenges farms face when there is too much or too little water available.
- Describe the importance of ecosystems and provide examples of ecosystems that are relevant to agricultural production.
- Describe the basic structure of plants and the way in which agricultural production accounts for optimal growing and harvesting conditions. Discuss the mechanical equipment used to grow, harvest, and process plant products.
- Explain how plants carry out photosynthesis to produce oxygen and energy.
- List the types of animals used in agricultural practice, the key factors that farmers must consider when raising and caring for these animals, and the types of equipment used in animal agriculture.
- Explain the types of energy sources used in agricultural production, the way that energy is created or obtained, and the use of agricultural commodities in producing alternative energy sources.
- Discuss how Global Positioning System (GPS) technology works and how it is used to improve agricultural production and environmental protection.

- Outline the types of equipment used in agricultural production and processing and the basic technologies involved in manufacturing and the use and repair of these equipment.

Mechanical System Design*

Hours: 30–40

Sample learning objectives

- Identify and demonstrate the ability to utilize basic hand tools, such as a dial caliper, a dial indicator, a torque wrench, and a combination square.
- Use a micrometer to make a precise measurement.
- Demonstrate the ability to use lifting equipment properly and safely.
- Identify bolt size, type, and grade.
- Discuss the types of agricultural equipment used by various industries based on local crops and geographic location.
- Demonstrate the ability to document plans and processes when servicing agricultural equipment.
- Explain how power take-off (PTO) systems work and how they transfer power to agricultural implements.
- Explain how belts, chains, and gears are used in powertrain systems to deliver power to conduct work.
- Discuss how guarding and shielding are accomplished in agricultural equipment to prevent injury to the operator.
- Follow standard diagnostic procedures to inspect equipment problems, make repairs, and verify operation following repair.
- Explain the role of agricultural equipment dealers in selling and maintaining agricultural equipment and the need for technicians and mechanics who work for or with these dealers to have strong communication skills.
- Demonstrate the ability to utilize written reports, such as work/repair orders, to communicate services provided to a customer.
- Conduct component failure analysis to analyze root cause failures.
- Demonstrate the ability to use service manuals to perform diagnostics and repairs on agricultural equipment, leading to a longer life in powertrain systems and reducing operation costs.

Drivetrains and Drive Systems*

Hours: 20

Sample learning objectives

- Explain how gears and sprockets establish and/or change a drivetrain's direction and speed.
- Explain how clutches transfer torque from the power input to the output.
- Discuss using bearings to reduce friction and increase efficiency in powertrain systems.
- Demonstrate the ability to set and adjust gears to work effectively.
- Demonstrate effective use of precision measurement tools to set preload and endplay in a powertrain system.
- Explain the role of differentials in maintaining equal torque at different speeds.
- Explain how final drives increase torque to the ground contact points.
- Explain using appropriate tires and tracks to provide traction in agricultural equipment when proper ground contact is applied.

Electrical and Digital Systems*

Hours: 30–40

Sample learning objectives

- Explain the use of series, parallel, and series-parallel circuits in agricultural equipment.
- Test for voltage, resistance, and continuity in an electrical component using a digital multimeter.
- Construct series, parallel and series-parallel circuits.
- Discuss how diodes protect electrical equipment by allowing power to flow only in one direction.
- Explain how electrical systems use alternating and direct current.
- Explain how rheostats and potentiometers vary the resistance in an electrical circuit to control current and voltage.
- Demonstrate the ability to read schematics when designing, constructing, and troubleshooting electrical circuits.
- Explain how electrical systems control engine systems' operation and function.
- Explain how agricultural equipment uses relays to control high amperage circuits that power specific components.
- Discuss how electrical systems use resistors, diodes, potentiometers, and relays to control equipment components.

- Demonstrate the ability to manage and troubleshoot controller systems used in precision agriculture.
- Define Ohm's law and demonstrate the use of diagnostic tools and Ohm's law to accomplish a systematic troubleshooting process.
- Describe the types of electrical systems used to control interactions between components and how technicians must maintain and troubleshoot those systems.
- Demonstrate the ability to properly use tools to troubleshoot and maintain GPS and Geographic Information System (GIS) equipment.

Precision Agriculture*

Hours: 30–40

Sample learning objectives

- Discuss the importance of equipment calibration in increasing the efficiency of outputs and limiting overlaps and skips in a field.
- Discuss the way in which precision systems use wireless connections to satellites to find a geographic location.
- Describe the use of controller systems in precision agriculture, including guidance systems, yield monitors, sensors, and automated outputs.
- Explain how precision agriculture increases production efficiencies that reduce application costs while improving yields.
- Explain how agricultural producers use sensors and automated controls to increase production efficiencies.
- Discuss the ways in which GIS displays maps as vectors, features, and attributes collected by guidance and remote systems.
- Explain how data collected from specific locations can be used to determine information for the entire field.
- Discuss the ways in which variable-rate application systems reduce producer costs protecting the environment.
- Discuss how GIS data management and analysis is a key component of utilizing GPS technology.
- Describe the remote sensing devices used in agricultural production to collect data to support production decisions.
- Demonstrate the ability to use data for predicting future repairs and maintenance needs.

Fluid Power*

Hours: 20–30

Sample learning objectives

- Use Pascal's Law to find the needed pressure and cylinder size for equipment.
- List and discuss the function of hydraulic system components, including pumps, control valves, actuators, and reservoirs.
- Properly use schematics to identify fluid power components and systems.
- Explain how hydraulic systems can be closed- or open-loop using positive or nonpositive pumps.
- Explain how a technician can control a hydraulic system's fluid flow and pressure.
- Discuss how Pascal's Law determines the system pressure and components needed for a machine to operate.
- Calculate pressure drop in a hydraulic system.
- Explain how fluid ratings for hydraulic systems are based on industry specifications and are specific to the equipment.
- Explain the safety hazards associated with working on hydraulic equipment and preventative measures technicians must take to reduce risk.
- Explain how hydrostatic transmissions use variable displacement pumps to transfer energy in a power train.
- Describe the use of electro-hydraulic systems to control cylinders in agricultural implements.
- Identify hydraulic systems used in agricultural equipment for steering, braking, drivetrains, and auxiliary equipment.
- Use proper techniques for correctly sealing hydraulic components and keeping them free of air and contaminants preventing wear and damage.
- Select fluid conductors and fittings based on system pressure and design.
- Demonstrate the ability to repair a hydraulic system, including flushing a system and inspecting it for particulate matter.

Diesel Technology*

Hours: 20–30

Sample learning objectives

- Describe the functional differences between diesel and gasoline engines.
- Explain the intake and fuel systems in diesel engines.
- Describe the types of lubrication and liquid cooling systems used in diesel engine systems.
- Explain the function of and identify the components of diesel injection systems, including solenoids and lift pumps.
- Describe the types of exhaust after-treatment systems that are required to make modern diesel engines EPA-compliant.
- List and explain the functions of essential components in high-pressure common rail diesel fuel systems.
- Explain how diesel engines use Controller Area Network (CAN) bus systems with Electronic Control Units (ECU) to monitor and control the engine.
- Explain the way in which a CAN bus allows a system of microcontrollers to control agricultural equipment.

Machine and Equipment Maintenance*

Hours: 30–40

Sample learning objectives

- Discuss ways in which technicians work with producers to manage and troubleshoot equipment for optimum agricultural production.
- Perform periodic maintenance and service procedures to improve the long-term performance of engines.
- Explain how environmental factors such as weather, humidity, cleanliness, and dust can impact the effectiveness of electrical systems in agricultural power and equipment.
- Treat fasteners to prevent corrosion and lubricate joints to prevent depreciation.
- Select fasteners based on their torque ratings and grades.
- Maintain maintenance and repair logs.
- Create an accurate work order to describe the actions taken to maintain or repair equipment.
- Provide effective customer service, including explaining to customers the reasoning behind repairs performed and how the customer should maintain the equipment after repair.
- Explain the repair or replacement recommended to a customer.

Optional Course: Air Conditioning and Heating*

Hours: 15–20

Sample learning objectives

- Explain the fundamental operating principles of AC and heating systems.
- Describe the environmental regulations determining how AC systems must be built and repaired.
- Troubleshoot, diagnose, service, and repair AC systems.
- Explain how heating systems function.
- Service heating systems.
- Explain the purpose of pressurized cabs and service and repair pressurization systems.

Relevant military experience

A variety of military occupations provide training in electronics, hydraulics, diesel mechanics, equipment maintenance, and equipment repair, all of which would prepare individuals to transition to occupations in agricultural equipment maintenance and repair.

Diversity, equity, and inclusion

Farm equipment technicians are mostly male (82 percent) and white (74.4 percent). 13.1 percent of these workers are Hispanic or Latino, 6.1 percent are Black or African American, 1.8 percent are Asian, and 0.7 percent are American Indian or Alaska Native. Average wages are significantly higher among Asian farm equipment technicians, followed by white workers, Black or African American workers, and Hispanic or Latino workers. Nearly half of the workers in this field hold bachelor's degrees, and the degree a worker holds significantly impacts the wages earned. Therefore, it is not clear whether differences in wages among various racial or ethnic groups are the result of differences in average level of educational attainment.

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