

Agricultural Equipment Technician Level 3

Agricultural Equipment Technician

Unit: E5 Basic Hydrostatic Operations, Schematics and Component Repair

Level: Three

Duration: 21 hours

Theory: 7 hours

Practical: 14 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with a working knowledge of diagnosing problems in advanced standard transmission systems and performing repair procedures.

Objectives and Content:

**Percent of
Unit Mark (%)**

- | | |
|--|------------|
| 1. Describe the fundamentals, design and operation of hydrostatic drives. | 40% |
| a. Hydrostatic drive theory | |
| b. Overall purpose and advantages | |
| • Hydrostatic drives vs. mechanical transmissions | |
| c. Basic components | |
| • Pistons and cylinder block | |
| • Swashplate | |
| -Fixed displacement | |
| -Variable displacement | |
| • Hydrostatic drive axles | |
| • Cam lobe motor | |
| • Brake | |
| • Destroke pump | |
| • Charge circuit | |
| • Control circuits | |
| -Electric & hydraulic | |
| d. Basic operation | |
| • Oil flow | |
| -Rate | |
| -Direction | |
| -Pressure | |
| • Neutral | |
| • Forward | |
| • Reverse | |
| 2. Describe and perform disassembly and reassembly procedures. | 40% |
| a. Fixed displacement driving variable/fixed motor | |
| b. Variable displacement driving variable/fixed motor | |

3. Describe maintenance procedures.

20%

- a. Key preventative precautions
 - Excessive speed
 - Heat & pressure
 - Contamination
- b. Maintenance preparation items
- c. Troubleshooting symptoms and remedies
 - System testing procedures
- d. Priming and start-up procedure

Agricultural Equipment Technician

Unit: D2 Engine Diagnosis, Troubleshooting, Startup and Dynotesting

Level: Three

Duration: 49 hours

Theory: 7 hours

Practical: 42 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with a working knowledge required to diagnose engine problems, as well as perform startup, tune-up and testing procedures.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
<p>1. Describe engine horsepower and torque.</p> <ul style="list-style-type: none"> a. Graphing of horsepower curve b. Graphing of torque curve c. Graphing of fuel consumption 	10%
<p>2. Describe and use specialized diagnostic measuring and diesel tools.</p> <ul style="list-style-type: none"> a. Diagnostic measuring tools <ul style="list-style-type: none"> • Infrared thermometer • Cylinder compression gauge • Manometer • Leakdown tester • Use of dynamometer b. Diesel tools <ul style="list-style-type: none"> • Injection puller/extractor • Diesel injector service set • Nozzle pop tester • Diesel injection timer • Opacity smoke meter • Computer system diagnostic tools <ul style="list-style-type: none"> -General description (covered in Level 3) 	20%
<p>3. Describe and perform the troubleshooting of engine compression and ignition problems.</p> <ul style="list-style-type: none"> a. Primary engine checks b. Cylinder balance <ul style="list-style-type: none"> • Procedures for various fuel systems • Evaluate results c. Air intake systems: restrictions and pressure d. Crankcase pressure testing 	25%

- Verification of PVC system operation
- Identification of cylinder sealing problems
- External oil leak diagnosis
- e. Exhaust back pressure test
- f. Compression tests
 - Test preparation procedures
 - Test procedures & interpretation of test results
- g. Cylinder leakdown tests
 - Procedures and precautions
 - Interpretation of results
- h. Smoke analysis
 - Overall concept
 - State of emission
 - White, black vs. blue smoke
- i. Low oil pressure
 - Procedures to verify problem
 - Causes and solutions
- j. High oil consumption
 - Procedures to verify problem
 - Causes and solutions
- k. High oil temperature
 - Procedures to verify problem
 - Causes and solutions
- l. High coolant temperature
 - Procedures to verify problem
 - Causes and solutions
- m. Low coolant temperature
 - Procedures to verify problem
 - Causes and solutions

4. Describe and perform troubleshooting strategies.

25%

- a. Overall purpose and benefits
- b. Need for troubleshooting
- c. Need for structure and sequence
- d. High exhaust pyrometer readings
 - Installation of master pyrometer
 - Chassis dynamometer
 - Causes and solutions
- e. Sudden engine stoppage
 - Causes and solutions
- f. Rough running engines
 - Causes and solutions
- g. Lack of power
 - "Lack of power" checklist
 - Possible causes and solutions
- h. Engine vibration
 - Cylinder misfire
 - Loose or defective vibration damper
 - Defective external component
 - solutions
- i. Soot in inlet manifold
 - Moderate vs. excessive soot

- j. Combustion knock
 - Fuel injection timing
 - Air in fuel
 - Low grade fuel
 - Out-of-balance MUIs
 - Solutions

5. Describe and perform engine startup and break-in.

20%

- a. Use of manuals as reference
- b. Static timing adjustment
- c. Turbocharger; air intake & cooling systems
- d. Fuel system precautions
- e. Proper startup procedures
- f. Final inspection
- g. Engine dynamometer run-in
 - Overall purpose
 - Gauge monitoring
 - Dynamometer operation and check

Agricultural Equipment Technician

Unit: E2 Differentials, Drive Axles & Final Drives

Level: Three

Duration: 16 hours

Theory: 4 hours

Practical: 12 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with the working knowledge required to service and repair differentials, drive axles and final drives.

Objectives and Content:

**Percent of
Unit Mark (%)**

1. **Describe the design, components and operations of differentials.**
 - a. Role and purpose of differentials
 - b. Differential assembly components
 - Drive pinion and ring gears
 - Differential pinions, side gears and pinion shaft
 - Limited slip differentials (clutch packs and brake cones)
 - c. Differential operation
 - d. Differential troubleshooting/diagnosis
 - Noise
 - Damaged differential gears and pinion shaft
 - Excessive clearance between pinion and ring gear
 - Excessive wear or loose and broken parts
 - Loose parts striking together
 - Vibrations or “chattering” around corner: clutch packs or cones
 - Differential lock not holding
 - e. Adjustment of differentials
 - f. Housing types
 - Integral
 - g. Final drive
 - Spur bevel
 - Spiral bevel
 - Helical
 - Hypoid
 - h. Gear set identification & tuning
 - Hunting & non-hunting
 - Partial hunting
 - i. Drive pinion mounting
 - Straddle & overhung
 - j. Drive axles and retention

40%

- k. Axle shafts
 - Live vs. dead axles
 - Full floating vs. semi-floating
 - Independently suspended axles
 - Axle shaft bearings (radial vs. thrust loading) & adjustments
 - l. Final drive assemblies
- 2. Perform diagnosis, inspection, testing and disassembly procedures on differential drive assemblies. 30%**
- a. Separation of shims, cups and caps
 - b. Uniform torque and alignment while installing ring gear
 - c. Adjustment of pinion gear depth (shims), bearing preload
 - d. Gear patterns and backlash
 - e. Bearing damage
 - f. Ring and pinion gears; excessive run-out and side play
 - g. Shim wear and damage
 - h. Differential case bearing preload
- 3. Describe the operation, components and maintenance procedures of final drives. 30%**
- a. Role and purpose of final drives
 - b. Types of final drives
 - Straight axle drive
 - Rigid axle shaft; full-floating & semi-floating axles
 - Pinion & spur gear final drives
 - Planetary drives
 - Operation
 - Parts construction
 - Mounting next to differential
 - Mounting at outer ends of final drives
 - Chain final drives
 - c. Final drive lubrication
 - d. Diagnosis of final drives
 - Excessive drive shaft endplay
 - Overheating & lack of lubricant
 - e. Adjustment of final drives
 - Adjusting axle bearings
 - Preloading bearings
 - Adjusting for end play

Agricultural Equipment Technician

Unit: E3 Powershift Transmissions and Torque Converters

Level: Three

Duration: 20 hours

Theory: 4 hours

Practical: 16 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with a working knowledge required to diagnose, service and repair problems related to power-shift transmissions and torque converters.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe torque converter fundamentals; perform disassembly and reassembly.	10%
a. Overall purpose and design	
2. Describe planetary gear sets and drive combinations.	10%
a. Overall purpose	
b. Basic components	
c. Planetary gear operation	
d. Drive combinations	
3. Describe power-shift transmission fundamentals; perform disassembly and reassembly.	50%
a. Hydraulic principles	
b. Gear train hydraulic control	
c. Transmission fluid	
• Purpose	
• Requirements	
• Cooling	
• Types, designations	
• Viscosity	
• Friction	
• Service intervals	
d. Planetary power-shift transmissions	
• Design & operation	
• Hydraulic system	
• Inching control	
• Clutch cutoff	
• Power flows	
e. Exhaust back pressure test.	

4. Describe the diagnosis and maintenance of power-shift transmissions.

30%

- a. Basic troubleshooting
 - Mechanical failure
 - Noises from worn bearings, shafts or splines (planetary gears)
 - Hydraulic system failure
 - Use of flow meters and test gauges
- b. Maintenance procedures
- c. Pressure testing
- d. Torque converter stall test
- e. Operator complaints
 - High temperature
 - Rough shifting
 - No transmission lockup

Agricultural Equipment Technician

Unit: E4 Advanced Standard Transmissions

Level: Three

Duration: 20 hours

Theory: 3 hours

Practical: 17 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with a working knowledge of diagnosing problems in advanced standard transmission systems and performing repair procedures.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe advanced standard transmission types.	20%
a. Multiple-speed and range transmissions	
b. Controller-operated transmissions	
c. Constant/ininitely variable transmissions	
2. Describe and perform disassembly, repair and maintenance.	80%
a. Disassembly and repair procedures	
b. Calibration procedures	

Agricultural Equipment Technician

Unit: F2 HVAC

Level: Three

Duration: 14 hours

Theory: 14 hours

Practical: 0 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice with the knowledge required to understand important MOPIA issues, and how they relate to shop operations. This unit also provides apprentices with the foundation knowledge required to diagnose, service and repair problems related to all key aspects of HVAC. **Note: In Manitoba, the MOPIA exam is administered by qualified instructors. Marks are determined by MOPIA.**

Objectives and Content:	Percent of <u>Unit Mark (%)</u>
<p>1. Describe provincial rules/regulations/legal requirements relating to ozone depleting substances and environmental issues.</p> <ul style="list-style-type: none"> a. Available refrigerant recovery and recycling equipment b. Refrigerant storage tank types: implications of use c. Provincial regulations: handling of recovered ozone depleting substances d. CFC code of practice e. MOPIA training 	20%
<p>2. Describe the fundamentals of air conditioning systems.</p> <ul style="list-style-type: none"> a. Methods of heat transfer <ul style="list-style-type: none"> • A/C thermodynamics • Refrigerant compressors • System lubrication b. Temperature and humidity relationship c. Solid, liquid and gas states d. Properties of refrigerants e. Alternative refrigerants f. Gas laws, temperature, pressure and volume g. Air conditioning thermo-dynamics <ul style="list-style-type: none"> • Heat absorption • Liquid and gas states • Temperature effects h. Thermal expansion and contraction i. Refrigerant waste law requirements 	30%
<p>3. Describe the design, function and operation of air conditioning systems.</p> <ul style="list-style-type: none"> a. Major components used in mobile air conditioning 	50%

- b. Major components and control location
 - Condenser
 - Receiver dehydration
 - Accumulator-dryer
 - Evaporator
 - Compressor
 - Hoses, lines and fittings
 - Cooling fans
 - Axial recirculating
 - Radial
 - Variable displacement
- c. Major components of A/C control systems
 - Low and high pressure cutout
 - Low charge protection
 - Evaporator temperature control
 - Cycling clutch control
 - Orifice tubes
 - Expansion valves
 - Fan controls
 - Low temperature lockout
- d. Refrigerant oils
- e. System operation
 - Control valves
 - Low and high pressure cutout
 - Low charge protection
 - Evaporator temperature control, including expansion valves
 - Cycling clutch control
 - Orifice tubes
 - Condenser
 - Receiver dryer (dehydrator)
 - Accumulator-dryer (dehydrator)
 - Evaporators
 - Compressors

Agricultural Equipment Technician

Unit: J2 Diesel Fuel Injection Systems: Diagnosis & Servicing

Level: Three

Duration: 70 hours

Theory: 25 hours

Practical: 45 hours

Overview:

This unit of instruction provides the Agricultural Equipment Technician apprentice an overall understanding of diesel fuel characteristics and systems. It also provides the working knowledge required to diagnose and repair fuel injection systems.

Objectives and Content:

**Percent of
Unit Mark (%)**

- | | |
|---|------------|
| 1. Describe alternative fuels. | 5% |
| a. Biodiesel | |
| b. Other alternative fuel types | |
| c. Safety considerations | |
| d. Source and refining process | |
| e. Advantages and disadvantages of alternative fuels | |
| f. Safety precautions | |
| g. Regulatory requirements | |
| 2. Describe compression and ignition principles. | 5% |
| a. Overall description and purpose | |
| b. 2-stroke vs. 4-stroke | |
| c. Gas vs. diesel | |
| 3. Describe the fundamentals of diesel fuel injection systems, diesel injection systems and perform the timing of injection pumps. | 50% |
| a. Timing | |
| b. Pressurizing | |
| c. Metering | |
| d. Distribution | |
| e. Key engine management objectives | |
| f. Overall description and purpose | |
| g. Technical description | |
| • Camshaft | |
| • Tappets | |
| • Plunger design & metering | |
| • Barrel | |
| • Delivery valve | |

- High pressure pipes
- h. System types
- i. Overall description and purpose
- j. Spill timing procedures
- k. Static timing
- l. Removal of metering injection pump
- m. Reinstallation

4. Describe tanks, lines and related service/repair procedures and fuel supply systems. 5%

- a. Fuel tank construction
 - Plated pressure steel, aluminum or molded plastic polyethylene
 - Baffles
 - Pick-up tubes
 - Passage for fuel transfer
 - Venting
 - Drain (optional)
 - Ridges
- b. Location and arrangement
 - Dual tanks
- c. Pressure and vacuum filler cap
 - Normal operating conditions
 - Pressure or vacuum conditions
 - Relief of vacuum pressure
- d. Venting of fuel tanks
 - Vapour separator and storage canister
 - Rollover protection (valve; inertia switch)
- e. Fuel re-circulating system
 - In-pump
 - In-line
- f. Fuel tank inspection
 - Fuel lines
 - Fuel leaks
 - Types
 - Fittings
 - Road damage
 - Corrosion
 - Rust
 - Loose
 - Defective seams
- g. Fuel tank removal and replacement procedures
- h. Fuel tank repair procedures
- i. Storage precautions: prevention of fuel contamination
- j. Safety precautions for fuel tanks
 - Disconnection of negative battery
 - Danger of heating bolts on fuel tank
 - Appropriate disposal of used rags and fuel
 - Leaks in steel tubing
 - Fuel line fittings to torque specifications
 - Proper fuel transfer system
 - Static electricity precautions
- k. Fuel lines

- Types
 - Fittings
 - Removal and installation procedures
 - Repair procedures
- i. Fuel filters
- Overall purpose and functions
 - Types
 - Cartridge
 - Canister
 - In-tank
 - Pleated paper
 - Screen
 - Stone or ceramic filter – sintered bronze
 - In-line filters
 - Primary filters
 - Secondary filters
 - Restriction indicator
 - Water indicator
 - Water separators
 - Limitation of filters
 - Location
 - Service procedures
 - Filling and bleeding procedures
 - Fuel heater and filter
 - Removal procedures
 - Design & testing
 - Installation procedures
 - Replacement precautions
 - Use of drain pan
 - Direction of flow and leaks in fuel line connections
 - Proper start of nut threads
 - Importance of cleanliness
 - Bleeding the system
- m. Fuel pumps
- Fuel tank sending units
 - Fuel charging/transfer pumps
 - Gear-types pumps
 - Hand primer pumps
 - Mechanical fuel pumps
 - Intake stroke
 - Outlet stroke
 - Rest stroke (chamber full, needle valve closed)
 - Pulsation damper principle and operation
 - Check valve
 - Diaphragm and spring
 - Rocker arm and spring
 - Pulsator diaphragm
 - Pump body (valve and lower body)
- n. Fuel systems – Problem diagnosis
- Low fuel pump pressure
 - High fuel pump pressure
 - Low fuel pump volume
 - Volume
 - Fuel pump leaks (fuel)
 - Fuel pump leaks (oil)
 - Fuel pump noise

- Flooding
- Choke malfunctioning
- Hard starting
- Loss of power
- Poor economy
- Poor idling & acceleration
- Fuel line restriction or leakage
- Clogged fuel filters
- Defective speed control linkage
- o. Fuel pumps: testing, repair and service procedures
 - Testing
 - Pressure
 - Vacuum
 - Delivery volume
 - Removal procedures
 - Disassembly of pump
 - Identification of parts
 - Reassembly procedures
 - Importance of cleanliness
 - Installation procedures
 - Priming a fuel system
 - Importance of refueling
 - Service intervals

5. Describe injector nozzles and perform nozzle testing and reconditioning. 10%

- a. Overall purpose
- b. Type
 - Hole
 - Pintle
 - Overall description and purpose
- c. Safety precautions
- d. Removal of injectors from the cylinder head
- e. Testing: procedures
- f. Reconditioning
- g. Reinstallation of injectors

6. Describe governors. 15%

- a. Overall function
- b. Terminology
- c. Mechanical governor
 - Limiting and variable speeds
- d. Servo-type governor
- e. Electronic governor
- f. Pneumatic governor

7. Describe emissions, emissions testing and controls. 10%

- a. Overall description and purpose
- b. Overall context of emissions legislation
- c. Aneroids
- d. Emission control devices
 - Types of catalytic converters
