

Diesel Technology: Engines

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Section A: Introduction to Engine Principles and Procedures

Unit 1–A: Engine Operating Principles

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| 1. Terms and definitions | 9. Identify companion cylinders |
| 2. Basic engine systems and their functions | 10. Locate and record engine specifications |
| 3. Basic diesel engine components | 11. Identify valve and piston position during each stroke |
| 4. Basic internal engine components and their functions | 12. Locate TDC for #1 piston |
| 5. Characteristics of gasoline and diesel engines | 13. Measure bore and stroke and compute engine displacement |
| 6. Four-stroke cycle | |
| 7. Two-stroke cycle | |
| 8. Characteristics of two-stroke and four-stroke diesel engines | |

Unit 2–A: Disassembly Procedures and Analysis

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| 1. Terms and definitions | 15. Determine required tools for various tasks |
| 2. Special engine tools and their functions | 16. Evaluate worn engine components |
| 3. Precision measuring instruments and their functions | 17. Determine possible causes of engine component failures |
| 4. Safety guidelines to following during engine removal and disassembly | 18. Steam clean an engine |
| 5. Good housekeeping practices and procedures | 19. Remove engine accessories and external lines |
| 6. Accessory components and lines that must be pulled (disconnected) before the engine is removed | 20. Remove engine and mount on an engine stand |
| 7. Methods for cleaning engine components | 21. Engine disassembly: Remove cylinder head |
| 8. Engine components that require measurement and analysis | 22. Engine disassembly: Remove gear train and camshaft |
| 9. Types of materials used on engine components and their applications | 23. Engine disassembly: Remove pistons and connecting rods |
| 10. Types of analyses | 24. Engine disassembly: Remove cylinder liners |
| 11. Eight steps of failure analysis | 25. Engine disassembly: Remove crankshaft |
| 12. Normal and abnormal wear | |
| 13. Common types of mechanical wear and their characteristics | |
| 14. Root causes of system failures | |

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Section B: Engine Systems And Components

Unit 1–B: Lubrication Systems

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| 1. Terms and definitions | 11. Factors to consider when choosing an engine oil |
| 2. Lubrication system components | 12. Service and install oil pump and oil pump drive components |
| 3. Functions of lubrication system components | 13. Service and inspect lubrication system screens and pipes |
| 4. Basic types of oil filters and their operations | 14. Service and inspect oil pressure regulator valve and bypass valve |
| 5. Basic oil pump designs and their operation | 15. Service and inspect oil cooler and lines |
| 6. Basic oil cooler designs | |
| 7. Basic oil cooler operation | |
| 8. Sources of oil contamination | |
| 9. Lubrication system monitor operation | |
| 10. API use codes | |

Unit 2–B: Cooling Systems

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|--|---|
| 1. Terms and definitions | 16. Flush, refill, and bleed coolant system |
| 2. Common types of cooling systems | 17. Inspect water pump, belts, and hoses |
| 3. Typical cooling system components for air-cooled engines | 18. Check operation of fan assembly and controls |
| 4. Typical cooling system components for liquid-cooled engines | 19. Test operation of thermostat installed in engine |
| 5. Cooling system operation | 20. Test operation of thermostat on the bench |
| 6. Effects of incorrect temperature regulation | 21. Check operation and accuracy of temperature indicating system |
| 7. Common types of radiators | |
| 8. Types of drives for water pumps | |
| 9. Parts of a water pump | |
| 10. Types of drive belts | |
| 11. Functions of coolant filters, conditioners, and additives | |
| 12. Types of antifreeze | |
| 13. Characteristics of a suitable antifreeze | |
| 14. Purposes of a radiator cap | |
| 15. Typical radiator cap operation | |

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Unit 3–B: Cylinder Blocks and Liners

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| 1. Terms and definitions | 6. Pressure test a cylinder block |
| 2. Types of cylinder block cooling methods | 7. Disassemble and clean a cylinder block |
| 3. Types of cylinder block liners (sleeves) | 8. Inspect a cylinder block |
| 4. Characteristics of cylinder liners (sleeves) | 9. Install new camshaft bushings |
| 5. Cause of abnormal sleeve wear | 10. Clean and inspect cylinder bores |
| | 11. Install cylinder liners and set liner protrusion |

Unit 4–B: Crankshafts and Bearings

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| 1. Terms and definitions | 15. Remove, clean, and inspect a crankshaft |
| 2. Parts of a crankshaft | 16. Install main bearings and crankshaft |
| 3. Crankshaft throw arrangements | 17. Perform an in-frame bearing roll-in |
| 4. Crankshaft throw characteristics | 18. Inspect viscous vibration damper/harmonic balancer |
| 5. Crankshaft balancing methods | 19. Inspect bonded vibration damper/harmonic balancer |
| 6. Crankshaft lubrication | 20. Inspect flywheel |
| 7. Characteristics of a good bearing | |
| 8. Bearing materials and their characteristics | |
| 9. Parts of main and connecting rod bearings | |
| 10. Special design features of main bearings | |
| 11. Types of thrust bearings | |
| 12. Symptoms of bearing failure | |
| 13. Types of vibration dampers | |
| 14. Functions of a flywheel | |

Unit 5–B: Pistons and Connecting Rods

1. Terms and definitions
2. Primary components of a piston and connecting rod assembly
3. Functions of piston and connecting rod components
4. Parts of a piston
5. Functions of piston parts
6. Common piston designs
7. Types of piston crown designs

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Unit 5–B: Pistons and Connecting Rods (continued)

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| 8. Types of piston rings and their functions | 16. Remove, disassemble, and inspect a piston and connecting rod assembly |
| 9. Common types of piston ring end gaps | 17. Measure piston-to-cylinder wall clearance and ring end gap |
| 10. Piston ring designs | 18. Assemble and install piston and connecting rod assembly |
| 11. Characteristics of piston ring designs | |
| 12. Parts of a connecting rod | |
| 13. Connecting rod parts and their descriptions | |
| 14. Common causes of abnormal piston wear | |
| 15. Possible causes of high oil consumption and blow-by | |

Unit 6–B: Camshafts, Trains, and Timing

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| 1. Terms and definitions | 14. Remove, clean, and inspect a camshaft |
| 2. Primary parts of a camshaft | 15. Remove, inspect, and install cam bushings |
| 3. Types of camshafts | 16. Install a camshaft and set cam timing |
| 4. Operation of a camshaft | |
| 5. Parts of a cam lobe | |
| 6. Parts of a valve train | |
| 7. Valve actuation | |
| 8. Valve timing | |
| 9. Types of camshaft bushings | |
| 10. Types of cam followers and lifters | |
| 11. Methods of driving the camshaft | |
| 12. Components in a typical gear train | |
| 13. Gear timing | |

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Unit 7–B: Cylinder Head Assemblies

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| 1. Terms and definitions | 11. Locate and label intake and exhaust valves |
| 2. Functions of a cylinder head | 12. Clean and inspect a cylinder head |
| 3. Basic differences between basic cylinder head designs | 13. Recondition a cylinder head |
| 4. Parts of a typical valve | 14. Install a cylinder head assembly and adjust valves |
| 5. Functions of valve parts | |
| 6. Basic valve assembly components | |
| 7. Functions of valve assembly components | |
| 8. Operation of a valve rotator | |
| 9. Common cylinder head problems | |
| 10. Common valve/seat problems | |

Unit 8–B: Air Induction and Exhaust Systems

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| 1. Terms and definitions | 14. Inspect and test air induction system |
| 2. Basic air induction components | 15. Inspect and service turbo/supercharger and related components |
| 3. Functions of air induction components | 16. Clean and test jacket water intercooler |
| 4. Types of air induction systems | 17. Clean and test air-to-air intercooler |
| 5. Main parts of a turbocharger | 18. Inspect and test exhaust system |
| 6. Starting aid devices | 19. Inspect starting preheater controls |
| 7. Basic exhaust system components | 20. Test starting fluid system and controls |
| 8. Functions of exhaust system components | |
| 9. Operation of an induction and exhaust system | |
| 10. Diesel engine scavenging | |
| 11. Exhaust systems | |
| 12. Parts of a typical catalytic converter | |
| 13. Operation of a catalytic converter | |

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Unit 9–B: Engine Brakes and Retarders

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| 1. Terms and definitions | 16. Remove, inspect, install, and adjust a Jacobs Engine Brake |
| 2. Common types of engine brakes and retarders | 17. Check operation of a BrakeSaver® |
| 3. Advantages of engine brake and retarder systems | 18. Check operation of an exhaust brake |
| 4. Engine compression brake components | 19. Remove, clean, and install an exhaust brake |
| 5. Functions of engine compression brake components | 20. Check operation of a driveline retarder |
| 6. Engine operation with the engine compression brake energized | |
| 7. Exhaust brake components | |
| 8. Functions of exhaust brake components | |
| 9. Engine operation with the exhaust brake energized (throttle-off operation) | |
| 10. Hydraulic engine retarder components (BrakeSaver®) | |
| 11. Functions of hydraulic engine retarder components | |
| 12. Engine operation with the hydraulic engine retarder energized | |
| 13. Electric driveline retarder components | |
| 14. Functions of electric driveline retarder components | |
| 15. Engine operation with an electric driveline retarder energized | |

Section C: Fuel Systems

Unit 1–C: Basic Fuel Systems and Components

1. Terms and definitions
2. Major functions of fuel systems
3. Major parts of a fuel system
4. Functions of fuel system parts
5. Parts of fuel tanks
6. Types of fuel transfer pumps
7. Types of primer pumps
8. Types of fuel injection systems

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Unit 1–C: Basic Fuel Systems and Components (continued)

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| 9. Methods of injecting fuel | 18. Trace fuel flow through basic fuel systems |
| 10. Types of controls on fuel systems | 19. Check fuel level, quality, and consumption |
| 11. Types of fuel lines and their functions | 20. Inspect and service basic fuel supply components |
| 12. Types of fuel filters | |
| 13. Types of governors | |
| 14. Classes of governors | |
| 15. Operation of the mechanical governor | |
| 16. Common maintenance problems on fuel systems | |
| 17. Factors that affect fuel consumption | |

Unit 2–C: Mechanical Fuel Injection Diagnosis and Repair

1. Terms and definitions
2. Parts of injection nozzles
3. Types of nozzle valves
4. Operation of an injection nozzle
5. Parts of mechanical unit injectors
6. Fuel flow through the unit injector
7. Optional features on fuel injection pumps
8. Main parts of a distributor-type injection pump
9. Functions of main parts of a distributor-type injection pump
10. Operation of distributor-type injection pumps
11. Fuel flow through distributor-type injection pumps
12. Main parts of an in-line injection pump
13. Functions of main parts of an in-line injection pump
14. Operation of an in-line injection pump
15. Parts and design features of a pumping element
16. Operation of control rack and sleeve
17. Plunger and rack positions
18. Types of PT injection pumps
19. Main parts of a PT injection pump

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Unit 2–C: Mechanical Fuel Injection Diagnosis and Repair (continued)

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| 20. Functions of the main parts of a PT injection pump | 24. Isolate, remove, test, rebuild or replace, and reinstall injection nozzles |
| 21. Operation of a PT injection pump | 25. Isolate, remove, test, and reinstall or replace mechanical unit injectors |
| 22. Types of PT injectors | 26. Inspect, test, adjust, and time a distributor-type (rotary) injection pump; determine needed repairs |
| 23. Operation of PT injectors | 27. Inspect, test, adjust, and time an in-line injection pump; determine needed repairs |
| | 28. Inspect, test, and adjust a PT injection pump and time the injectors; determine needed repairs |

Unit 3–C: Electronic Fuel Injection Diagnosis and Repair

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| 1. Terms and definitions | 13. Inspect and test power and ground circuits and connections; determine needed repairs |
| 2. Parts of a typical electronic fuel system | 14. Check diagnostic trouble codes using electronic diagnostic equipment and technical information; determine needed repairs |
| 3. Fuel flow through an electronic fuel system | 15. Inspect and replace electrical connectors, terminals, seals, and locks |
| 4. Parts of an electronic unit injector | 16. Access engine parameters; monitor or change as requested by customer |
| 5. Advantages of electronic fuel injection over mechanical fuel injection | 17. Remove, inspect, and rebuild or replace a fuel transfer pump |
| 6. Common types of electronic fuel injection systems | 18. Remove, inspect, reinstall, and adjust electronic unit injectors; determine needed repairs |
| 7. Basic categories of electronic components | |
| 8. Common electronic sensors | |
| 9. Common electronic acronyms or abbreviations and their meanings | |
| 10. Specialty tools and equipment used for electronic diagnosis | |
| 11. Basic types of diagnostic codes | |
| 12. Electronic identification message codes | |

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Unit 4–C: Emissions

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| 1. Terms and definitions | 11. Check vehicle for presence and operation of emission control devices |
| 2. Diesel fuel combustion reaction | 12. Check vehicle for fuel type and appropriate application |
| 3. Exhaust emissions and their characteristics | 13. Test vehicle for excessive exhaust smoke |
| 4. Types of smoke emissions | 14. Check vehicle for noise abatement devices |
| 5. Environmental issues affected by emissions | |
| 6. Federal Clean Air Act | |
| 7. Tests for emissions | |
| 8. Efforts to improve emissions | |
| 9. Alternative/clean fuels | |
| 10. Methods for reducing noise levels | |

Section D: Engine Diagnosis and Maintenance

Unit 1–D: General Engine Diagnosis

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| 1. Terms and definitions | 11. Conduct an operator survey for engine diagnosis |
| 2. Steps used in evaluating engine performance | 12. Interpret SAE code identifiers |
| 3. Benefits of the operator questionnaire | 13. Check air intake system for restrictions |
| 4. Major checkpoints in a visual inspection | 14. Check exhaust back pressure |
| 5. Major performance checkpoints | 15. Check crankcase pressure |
| 6. Performance tests made with the engine on a dynamometer | 16. Check oil pressure |
| 7. Functions of engine computer fault detection | 17. Load test an engine on a dynamometer |
| 8. Engine computer fault code storage | 18. Locate a misfiring cylinder |
| 9. Engine computer fault code retrieval | 19. Locate an active fault code |
| 10. SAE code identifiers | |

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Unit 2–D: Preventive Maintenance and Tune-Up

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| 1. Terms and definitions | 9. Determine maintenance needed for given situations |
| 2. Purposes of preventive maintenance and tune-up | 10. Interpret maintenance troubleshooting charts |
| 3. Locating preventive maintenance charts and information | 11. Inspect engine coolant level and condition |
| 4. Ways of designating preventive maintenance intervals | 12. Pressure test coolant system and radiator cap |
| 5. Conditions that require severe service maintenance schedules | 13. Take oil sample, and change oil and filter(s) |
| 6. Engine areas requiring preventive maintenance | 14. Inspect and test indicator system components |
| 7. Preventive maintenance tasks for diesel fuel systems | 15. Perform a daily preventive maintenance check |
| 8. Diesel engine tune-up sequence | 16. Perform a mileage preventive maintenance check |
| | 17. Perform an engine tune-up |