SkillsUSA®
CHAMPIONSHIPS

DIESEL EQUIPMENT TECHNOLOGY

SkillsUSA Championships Technical Standards

PURPOSE

To evaluate each competitor's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of diesel equipment technology.

ELIGIBILITY

Open to active SkillsUSA members enrolled in programs with diesel equipment technology as an occupational objective.

CLOTHING REQUIREMENT

Class D: Competition Specific — Blue Attire

- Official SkillsUSA light blue work shirt
- Navy pants
- Black, brown, or tan work safety shoes (with protective toe cap)

Note: Safety glasses must have side shields or goggles. (Prescription glasses may be used only if they are equipped with side shields. If not, they must be covered with goggles.)

These regulations refer to clothing items that are pictured and described at: www.skillsusastore.org. If you have questions about clothing or other logo items, call 1-888-501-2183.

Note: Competitors must wear their official competition clothing to the competition orientation meeting.

SAFETY INSTRUCTION AND VERIFICATION OF TRAINING

Important: Both the instructor and the competitor certify by agreeing to enter this competition that the competitor has received instruction in diesel technology and has demonstrated knowledge of the operation and safe use of the following tools, equipment, and machines:

1. Oxyacetylene welding and cutting
2. Drill press
3. Hand tools
4. Hydraulic systems
5. Electric welding
6. Metal grinders

They also certify that SkillsUSA Inc., the national technical committee and national judges are released from all responsibilities relating to personal injury resulting from their use.

Competitors will be removed from competition if proper training has not been provided and/or they are using the equipment in an unsafe manner.

EQUIPMENT AND MATERIALS

1. Supplied by the technical committee:
   a. All materials, tools and equipment needed for the competition
2. Supplied by the competitor:
   a. All competitors must create a one-page resume. See "Resume Requirement" below for guidelines

RESUME REQUIREMENT

Competitors must create a one-page resume to submit online. SkillsUSA South Carolina competitors should submit their resume by the deadline published on the competition updates page of our website. Failure to submit a resume will result in a 10-point penalty.

Your resume must be saved as a PDF file type using file name format of "Last Name_First Name." For example, "Amanda Smith" would save her resume as Smith_Amanda. If you need assistance with saving your file as a PDF, visit the Adobe website for more information.

Note: Check the Competition Guidelines and/or the updates page on the state website.

PROHIBITED DEVICES

Cellphones, electronic watches and/or other electronic devices not approved by a competition's national technical committee are ***NOT*** allowed in the competition area. Please follow the guidelines in each technical standard for approved exceptions. Technical committee members

may also approve exceptions onsite during the SkillsUSA Championships if deemed appropriate.

Penalties for Prohibited Devices

If a competitor's electronic device makes noise or if the competitor is seen using it at any time during the competition, an official report will be documented for review by the Director of the SkillsUSA Championships. If confirmed that the competitor used the device in a manner which compromised the integrity of the competition, the competitor's scores may be removed.

SCOPE OF THE COMPETITION

The competition is defined by industry standards as identified by SkillsUSA technical committee, which includes: Air Products, ArvinMeritor Automotive Inc., Caterpillar Inc., Cummins Inc., Detroit Diesel Corp., Eaton Corp., FedEx Freight, International Truck and Engine Corp., J. Jeb Mfg. Co., John Deere Construction and Forestry, Kenworth Truck Co., Meritor WABCO, MTU-Detroit Diesel Inc., National Institute for Automotive Service Excellence, Ohio Technical College, Ryder Systems Inc., United Parcel Service, and Volvo Trucks of North America Inc.

KNOWLEDGE PERFORMANCE

The competition will include a written exam to assess knowledge of principles, theories, and procedures used in diesel equipment technology.

SKILLS PERFORMANCE

The competition will include a series of stations where students will service and repair large diesel engines, transmissions, drivetrains, electrical systems, brakes, hydraulic systems and cab components used in farm equipment, trucks and construction equipment.

COMPETITION GUIDELINES

1. Competitors may be assigned problems or projects requiring as little as 20 minutes, or as long as four hours to perform.
2. The following general shop safety rules will be followed:
    a. Safety glasses must be worn at all times when in the work area. If the competitor is taking a written test or is in a job interview, safety glasses may be removed.
    b. No loose clothing is permitted.
    c. Long hair must be tied behind the head or netted.
    d. Gloves must not be worn during operation of machinery, except while doing electric welding, oxyacetylene welding, and cutting operations.
    e. Any liquid or grease spilled must be cleaned up immediately and reported to the judge.
    f. All injuries, no matter how minor, must be reported immediately to the judge.
3. In addition, competitors will be judged on general shop skills, problem-solving skills, shop safety, and a written test. Points will be assigned by the technical committee based on the difficulty of the assigned task.

STANDARDS AND COMPETENCIES

DET 1.0 — Precision Measurements

1.1. Interpret and follow verbal instructions.
1.2. Interpret and follow written instructions.
1.3. Read and explain basic prints.
1.4. Use dial indicator.
1.5. Calibrate dial indicator.
1.6. Use valve spring compressor to remove valve from head.
1.7. Use valve spring compressor to install valve in head.
1.8. Use metric micrometers.
1.9. Use U.S. standard micrometers.
1.10. Record metric measurements correctly.
1.11. Record U.S. standard measurements correctly.
1.12. Use bore gauge correctly.
1.13. Compare readings taken with standards to determine if part is within manufacturer's specifications.
1.14. Demonstrate knowledge of tolerances.
1.15. Use dial calipers.
1.16. Calibrate dial calipers.
1.17. Use an inside telescoping gauge.
1.18. Use a depth micrometer.

DET 2.0 — Engine Technology

2.1. Demonstrate an understanding of the 4-stroke internal combustion cycle.
2.2. Demonstrate knowledge of basic engine components.
2.3. Demonstrate knowledge of the two basic cylinder block configurations: inline and V.
2.4. Demonstrate an understanding of basic engine systems.
2.5. Demonstrate an understanding of engine performance terminology.
2.6. Demonstrate an understanding of engine rating performance specifications.
2.7. Inspect engine assembly for fuel, oil, coolant, and other leaks to determine needed repairs.
2.8. Inspect push rods for damage.
2.9. Repair damaged threads.
2.10. Inspect and replace drive belts and pulleys.
2.11. Remove and install/replace camshaft and bearings.
2.12. Remove, inspect, and install pistons, connecting rods, piston rings, and cylinder liners.
2.13. Remove and install crankshaft and bearings.
2.14. Remove and install engine seals and gaskets.
2.15. Replace pilot bushing/bearing.
2.16. Replace flywheel ring gear.
2.17. Calculate engine displacement.
2.18. Locate top dead center.
2.19. Check the cylinder head flatness and cylinder liner projection.
2.20. Measure cylinder bore.
2.21. Measure piston stroke.
2.22. Check flywheel wear and flatness.

2.23. Remove and install engine front housing.
2.24. Remove and install engine rear housing.
2.25. Remove, install, and align the timing gears.
2.26. Remove and install valve mechanism, including the rocker arms and push rods.
2.27. Measure crankshaft endplay.
2.28. Remove and install inlet valves, exhaust valves, valve springs, valve guides, valve rotators and valve seats.
2.29. Perform bridge adjustments.
2.30. Set inlet and exhaust valves.
2.31. Measure a camshaft lobe.
2.32. Remove and install intake manifold.
2.33. Remove and install exhaust manifold.
2.34. Perform a cylinder compression test.
2.35. Perform dynamometer test.
2.36. Demonstrate knowledge of a diesel engine cooling system.
2.37. Demonstrate knowledge of overcooling and undercooling.
2.38. Perform cooling system pressure test.
2.39. Test the cooling system cap.
2.40. Perform a pressure test on the oil cooler and radiator.
2.41. Demonstrate an understanding of the oil flow through a typical engine lubrication system.
2.42. Perform the oil system pressure test.
2.43. Demonstrate knowledge of a typical air inlet and exhaust system used on diesel engines.
2.44. Perform an exhaust/smoke analysis.
2.45. Perform an exhaust backpressure test.
2.46. Measure manifold (boost) pressure.
2.47. Perform the air-to-air aftercooler (ATAAC) system test and adjust procedures.
2.48. Perform a compression brake adjustment.
2.49. Demonstrate an understanding of operation and components of the basic diesel engine fuel system.
2.50. Conduct Cetane rating test procedure.
2.51. Find the fuel specific gravity.
2.52. Adjust a mechanical governor.
2.53. Determine fuel line failures and damage.
2.54. Disassemble and assemble a direct injection nozzle.
2.55. Test direct injection valve opening pressure.
2.56. Test precombustion chamber capsule type injection valve opening pressure.
2.57. Test pencil type injection valve opening pressure.
2.58. Perform a return leakage test.
2.59. Demonstrate an understanding of operation and components of the air fuel ratio control.
2.60. Test an air fuel ratio control.
2.61. Remove and replace an air fuel ratio control.
2.62. Disassemble and assemble an air fuel ratio control.
2.63. Adjust an air fuel ratio control with the engine not running.
2.64. Adjust the air fuel ratio control with the engine running.
2.65. Remove and replace the timing advance unit.
2.66. Adjust the static timing on a timing advance unit.

2.67. Disassemble and assemble a timing advance unit.
2.68. Remove and install a fuel filter.
2.69. Remove and install a fuel shutoff solenoid.
2.70. Remove and install a precombustion chamber capsule type nozzle.
2.71. Remove and install a direct injection capsule type nozzle.
2.72. Remove and install a pencil type fuel injector.
2.73. Remove and install an early scroll fuel injection pump.
2.74. Remove and install a new scroll fuel injection pump.
2.75. Remove and install a sleeve metering fuel injection pump.
2.76. Remove and install a rotary vane fuel injection pump.
2.77. Remove and install a piston style fuel injection pump.
2.78. Remove and install a fuel injection rack.
2.79. Remove and install a fuel injection camshaft.
2.80. Remove and install a lift/priming pump.
2.81. Remove and install a transfer pump.
2.82. Remove and install a priming pump.
2.83. Remove and install a pressure sensor.
2.84. Remove and install a speed-timing sensor.
2.85. Remove and install a hydraulic actuation pump.
2.86. Perform cylinder cutout test.
2.87. Calibrate engine timing.
2.88. Calibrate a sensor.
2.89. Perform a solenoid test.
2.90. Perform an injection actuation test.
2.91. Change fuel settings.
2.92. Perform a wiggle test with an injector.
2.93. Check/adjust injection pump timing.
2.94. Perform a rack synchronization adjustment.
2.95. Check and adjust the timing advance.
2.96. Perform fuel system flow test on an injection test bench.
2.97. Perform a fuel system restriction inspection.
2.98. Perform fuel system pressure test on the low-pressure side of the fuel system.
2.99. Test and adjust fuel injection nozzles or injectors.
2.100. Adjust engine idle speed.
2.101. Check maximum governed rpm with no load.

DET 3.0 — Electrical Systems

3.1. Demonstrate an understanding of resistance.
3.2. Demonstrate an understanding of electrical circuits and laws.
3.3. Demonstrate an understanding of electrical conductors and insulators.
3.4. Demonstrate an understanding of wires.
3.5. Demonstrate an understanding of magnetism.
3.6. Demonstrate an understanding of electromagnets.
3.7. Demonstrate an understanding of relays and solenoids.
3.8. Demonstrate an understanding of electromagnetic induction.
3.9. Demonstrate an understanding of basic electrical circuit elements.
3.10. Demonstrate an understanding of Ohm’s Law.

3.11. Calculate voltage, current, and resistance in a basic electrical circuit using Ohm's Law.
3.12. Demonstrate an understanding of a series circuit.
3.13. Demonstrate an understanding of a parallel circuit.
3.14. Demonstrate an understanding of a series-parallel circuit.
3.15. Calculate voltage, current, and resistance in series, parallel, and series-parallel electrical circuits using Ohm's Law.
3.16. Demonstrate an understanding of the metric system of measurement.
3.17. Measure voltage, current, and resistance in series, parallel, and series-parallel electrical circuits using a digital multimeter.
3.18. Identify electrical circuit faults including an open, short, and high resistance.
3.19. Demonstrate an understanding of wiring, connectors, and basic electrical components.
3.20. Demonstrate an understanding of solid-state electrical components.
3.21. Demonstrate an understanding of electrical schematics and electrical symbols.
3.22. Test an electrical circuit using a multimeter to determine how basic electrical components effect circuit operation.
3.23. Test an electrical circuit using a multimeter to determine how solid-state electrical components effect circuit operation.
3.24. Replace common types of electrical connectors on wiring harnesses.
3.25. Replace a machine lighting circuit component.
3.26. Replace a machine accessory circuit component.
3.27. Repair electrical wiring and electrical connectors using proper soldering techniques.
3.28. Test a machine lighting circuit to determine fault and make necessary repairs.
3.29. Test a machine accessory circuit to determine fault and make necessary repairs.
3.30. Demonstrate an understanding of battery construction and battery operation.
3.31. Identify types of batteries and battery ratings.
3.32. Demonstrate an understanding of AC and DC charging circuits.
3.33. Demonstrate an understanding of generator and alternator components and operation.
3.34. Demonstrate an understanding of voltage induction and current rectification.
3.35. Demonstrate an understanding of voltage regulation.
3.36. Demonstrate an understanding of charging system indicator operation.
3.37. Demonstrate an understanding of starting motor components and operation.
3.38. Demonstrate an understanding of starting circuit components and operation.
3.39. Perform battery charging procedures.
3.40. Perform vehicle jump starting procedures.
3.41. Perform battery maintenance procedures.
3.42. Perform a specific gravity test on a conventional battery.
3.43. Perform a load test on a battery.
3.44. Perform an alternator output test on the equipment.
3.45. Perform a regulator test on the equipment.
3.46. Disassemble, test, and reassemble alternator.
3.47. Perform starter tests on the equipment.
3.48. Perform a no-load starter test off the equipment.
3.49. Disassemble, test, and reassemble starter motor.
3.50. Demonstrate an understanding of electronic control system input and output components.
3.51. Demonstrate an understanding of electronic control modules (ECMs).
3.52. Test a switch in an electronic control system and replace as necessary.

3.53. Test a resistive type sender in an electronic control system and replace as necessary.
3.54. Test an analog sensor in an electronic control system and replace as necessary.
3.55. Test a digital sensor in an electronic control system and replace as necessary.
3.56. Test a frequency sensor in an electronic control system and replace as necessary.
3.57. Test a relay in an electronic control system and replace as necessary.
3.58. Test a solenoid in an electronic control system and replace as necessary.
3.59. Test an indicator lamp in an electronic control system and replace as necessary.

DET 4.0 — General Shop Skills

4.1. Demonstrate the use of proper PPE throughout the station.
4.2. Demonstrate proper safety procedures throughout the station.
4.3. Demonstrate the ability to work safely throughout the station.
4.4. Demonstrate the ability to properly use an oxygen acetylene cutting torch.
4.5. Demonstrate the ability to safely use an oxygen acetylene cutting torch.
4.6. Demonstrate an understanding of proper procedures when using an oxygen and acetylene torch.
4.7. Demonstrate knowledge of compressed gas cylinders and proper operation and handling.
4.8. Demonstrate knowledge of oxygen acetylene cutting torch operation.
4.9. Demonstrate proper handling of pressurized oxygen and acetylene gauges.
4.10. Demonstrate ability to properly adjust oxygen and acetylene gauges.
4.11. Demonstrate ability to properly light an oxygen and acetylene torch.
4.12. Demonstrate ability to properly adjust an oxygen and acetylene cutting flame.
4.13. Demonstrate ability to properly use a cutting torch.
4.14. Demonstrate ability to properly shut down an oxygen and acetylene torch.
4.15. Demonstrate the ability to pay attention to instructions.
4.16. Demonstrate the ability to follow orders.
4.17. Demonstrate the ability to read a schematic.
4.18. Demonstrate the ability to complete the task.
4.19. Demonstrate the ability to assemble to a standard.
4.20. Demonstrate the ability to properly set up an arc welder properly.
4.21. Demonstrate the ability to properly operate an arc welder.
4.22. Demonstrate the ability to safely use an arc welder.
4.23. Demonstrate knowledge of proper arc welder operation.
4.24. Demonstrate knowledge of proper heat range for size of work.
4.25. Demonstrate knowledge of proper welding rod for size of work.
4.26. Demonstrate ability to strike an arc.
4.27. Demonstrate ability to hold an arc.
4.28. Demonstrate ability to strike an arc.
4.29. Demonstrate ability of proper rod angle.
4.30. Demonstrate ability of proper weld speed.
4.31. Demonstrate ability of proper weld direction.
4.32. Demonstrate ability to lay a quality weld.
4.33. Demonstrate ability to shut down the equipment properly.
4.34. Demonstrate ability to put away all tools.

DET 5.0 — Chassis

5.1. Test and adjust the power train hydraulic system pressures.
5.2. Calibrate the power train electronic control system.
5.3. Demonstrate an understanding of standard differential components and operation.
5.4. Demonstrate an understanding of differential and bevel gear group adjustments.
5.5. Demonstrate an understanding of differential steering components.
5.6. Demonstrate an understanding of differential steering power flow.
5.7. Demonstrate an understanding of differential steering operation.
5.8. Remove and install a differential and bevel gear.
5.9. Disassemble and assemble a standard differential.
5.10. Disassemble and assemble a locking differential.
5.11. Disassemble and assemble a limited slip differential.

DET 6.0 — Transmission Technology

6.1. Demonstrate basic shop safety procedures.
6.2. Demonstrate basic air system safety procedures.
6.3. Demonstrate basic electrical safety procedures.
6.4. Demonstrate basic operation of a digital multimeter.
6.5. Demonstrate knowledge of automated transmission components.
6.6. Demonstrate the ability to follow troubleshooting processes and procedures.
6.7. Demonstrate knowledge of the fault code isolation procedure.
6.8. Demonstrate the ability to correctly read, interpret, and diagnose fault code(s) and/or symptoms associated with automated transmissions.
6.9. Demonstrate the ability to inspect, confirm and verify operation of supplied automated transmission components.
6.10. Demonstrate the use of Eaton Cummins Automated Transmission service literature and service tools.
6.11. Demonstrate basic knowledge of available Eaton Cummins Automated Transmission service literature (Internet/Web Base).
6.12. Demonstrate basic parts identification in supplied literature. Either hard copy or electronic version.

DET 7.0 — Drive Axles

7.1. Test and adjust the power train hydraulic system pressures.
7.2. Calibrate the power train electronic control system.
7.3. Demonstrate an understanding of standard differential components and operation.
7.4. Demonstrate an understanding of differential and bevel gear group adjustments.
7.5. Demonstrate an understanding of differential steering components.
7.6. Demonstrate an understanding of differential steering power flow.
7.7. Demonstrate an understanding of differential steering operation.
7.8. Remove and install a differential and bevel gear.
7.9. Disassemble and assemble a standard differential.
7.10. Disassemble and assemble a locking differential.
7.11. Disassemble and assemble a limited slip differential.

DET 8.0 — Job Interview Skills

8.1. Demonstrate knowledge of work history by filling out a job application.
8.2. Demonstrate speaking proficiency by answering questions in an interview.
8.3. Demonstrate professional posture and experiences.
8.4. Produce a clear and coherent professional resume as a formal document of professional background and relevant skills.

DET 9.0 — Hydraulic Systems

9.1. Demonstrate basic hydraulic safety procedures.
9.2. Demonstrate knowledge of hydraulic components.
9.3. Demonstrate knowledge of hydraulic principles of liquids.
9.4. Demonstrate knowledge of hydraulic principles of Gas.
9.5. Demonstrate an understanding of Pascal's Law.
9.6. Demonstrate an understanding of hydraulic flow, pressure, and resistance to flow.
9.7. Demonstrate an understanding of hydraulic system ISO symbols.
9.8. Demonstrate knowledge of pressurized hydraulic tanks.
9.9. Demonstrate knowledge of vented hydraulic tanks.
9.10. Demonstrate knowledge of hydraulic oil functions.
9.11. Demonstrate knowledge of using a hydraulic oil viscosity index.
9.12. Demonstrate knowledge of hydraulic oil life.
9.13. Demonstrate knowledge of a hydraulic hose.
9.14. Demonstrate knowledge of hydraulic hose couplings.
9.15. Demonstrate knowledge of basic functions of hydraulic pumps and motors.
9.16. Demonstrate knowledge of centrifugal impeller pumps.
9.17. Demonstrate knowledge of axial propeller pumps.
9.18. Demonstrate knowledge of volumetric efficiency of hydraulic pumps.
9.19. Demonstrate knowledge of gear type hydraulic pumps.
9.20. Demonstrate knowledge of vane type hydraulic pumps.
9.21. Demonstrate knowledge of piston pumps and motors.
9.22. Demonstrate knowledge of pump and motor ISO symbols.
9.23. Demonstrate knowledge of the different types of pressure relief valves.
9.24. Demonstrate knowledge of sequence valves.
9.25. Demonstrate knowledge of pressure reducing valves.
9.26. Demonstrate knowledge of pressure differential valves.
9.27. Demonstrate knowledge of the open center vs. closed center control valves.
9.28. Demonstrate knowledge of rotary type control valves.
9.29. Demonstrate knowledge of check valves.
9.30. Demonstrate knowledge of makeup valves.
9.31. Demonstrate knowledge of solenoid actuated control valves.
9.32. Demonstrate knowledge of ISO drawings for directional control valves.
9.33. Demonstrate knowledge of the different types of fixed orifice valves.
9.34. Demonstrate knowledge of variable orifice valves.
9.35. Demonstrate knowledge of non-compensated flow control valves.
9.36. Demonstrate knowledge of bypass pressure compensated flow control valves.
9.37. Demonstrate knowledge of a restriction type pressure-compensated flow control valve.
9.38. Demonstrate knowledge of quick drop valves.
9.39. Demonstrate knowledge of ISO symbols for flow control valves.

9.40. Demonstrate knowledge of series vs. parallel hydraulic circuits.
9.41. Demonstrate knowledge of the components and actuation of single acting cylinders.
9.42. Demonstrate knowledge of the components and actuation of double acting cylinders.
9.43. Demonstrate knowledge of seals and the purpose of each in hydraulic cylinders.
9.44. Demonstrate knowledge of cylinder snubbers (dampers).
9.45. Demonstrate knowledge of piston bypass valves.
9.46. Demonstrate an understanding of the major components of pilot operated hydraulic systems.
9.47. Demonstrate an understanding of the oil flow in a pilot operated hydraulic system schematic.
9.48. Demonstrate an understanding of the implementation of pilot control valves.
9.49. Demonstrate an understanding of the implement hydraulic control valves.
9.50. Demonstrate an understanding of the oil flow in a command control steering hydraulic system schematic.
9.51. Demonstrate an understanding of the major components of a command control steering system.
9.52. Demonstrate an understanding of a steering pilot control valve.
9.53. Remove and install the implement hydraulic control valves.
9.54. Remove and install the pilot relief valve.
9.55. Remove and install the main relief valve/pressure limiter in the hydraulic system.
9.56. Remove and install a line relief/makeup valve.
9.57. Disassemble and assemble the lift and hydraulic control valves.
9.58. Disassemble and assemble the pilot relief valve.
9.59. Disassemble and assemble the main relief valve/pressure limiter in the hydraulic system.
9.60. Disassemble and assemble a line relief/makeup valve.
9.61. Adjust the pilot system relief or pressure control valve.
9.62. Adjust the main relief valve/pressure limiter in a hydraulic system.
9.63. Adjust the line relief/makeup valves.
9.64. Demonstrate an understanding of Load Sensing Pressure Compensated hydraulic system definition.
9.65. Demonstrate an understanding of Proportional Priority Pressure Compensated hydraulic system definition.
9.66. Demonstrate an understanding of basic components of LSPC hydraulic systems.
9.67. Demonstrate an understanding of pressure compensated hydraulic systems.
9.68. Demonstrate an understanding of load sensing hydraulic systems.
9.69. Demonstrate an understanding of the differences between the LSPC hydraulic system compared to the PPPC system.
9.70. Demonstrate an understanding of load sensing signal network.
9.71. Demonstrate an understanding of an LSPC hydraulic control valve.
9.72. Demonstrate an understanding of a PPPC hydraulic control valve.
9.73. Demonstrate an understanding of how the flow compensator valve in the LSPC hydraulic differs from one in a PPPC system.
9.74. Remove and install the pump control valve on a load sensing pump.
9.75. Remove and install a load sensing pump.
9.76. Remove and install a signal limiter valve in a PPPC hydraulic system.
9.77. Disassemble and assemble the pump control valve on a load sensing pump.

9.78. Disassemble and assemble a load sensing pump.
9.79. Disassemble and assemble a signal limiter valve in a PPPC hydraulic system.
9.80. Adjust the high pressure cutoff on a load sensing pump.
9.81. Adjust the margin pressure or standby pressure for a load sensing pump.
9.82. Perform the case drain test on a piston pump or motor.
9.83. Demonstrate an understanding of open and closed loop hydrostatic drive systems.
9.84. Demonstrate an understanding of the major components of a hydrostatic drive system.
9.85. Demonstrate an understanding of fixed and variable pump and motor combinations.
9.86. Demonstrate an understanding of one direction or bi-directional oil flow.
9.87. Demonstrate an understanding of crossover relief valves.
9.88. Demonstrate an understanding of the flushing system for motors.
9.89. Demonstrate an understanding of the charging pump system.
9.90. Demonstrate an understanding of drive pump control valves.
9.91. Demonstrate an understanding of drive motor control valves.
9.92. Demonstrate an understanding of a hydrostatic fan drive system.
9.93. Demonstrate an understanding of the Mechanical/Hydraulic Dual Hydrostatic Drive system.
9.94. Demonstrate an understanding of the Electro-Hydraulic Dual Hydrostatic Drive.
9.95. Remove and install a hydraulic drive fan motor.
9.96. Remove and install a travel cross-over relief valve in an excavator travel motor.
9.97. Disassemble and assemble a hydraulic drive fan motor.
9.98. Disassemble and assemble a travel cross-over relief valve.
9.99. Adjust the fan speed on a hydrostatic fan drive system.
9.100. Perform the hydrostatic drive loop stall test.
9.101. Test and adjust the Electro-hydraulic Dual Hydrostatic Drive System.
9.102. Test and adjust the mechanical/hydraulic Dual Hydrostatic Drive System.
9.103. Test and adjust the cross-over line relief valves.
9.104. Test and adjust a drive loop equipped with pressure override valves.
9.105. Test and adjust the under speed cut-in speed on a HPCU equipped machine.
9.106. Test and adjust a speed sensing valve on a Compact Construction Equipment machine.
9.107. Test and adjust the charge pressure on a Compact Construction Equipment machine.
9.108. Test and adjust the pilot pressure on a Compact Construction Equipment machine.
9.109. Determine the case drain pressure on each motor of a mechanical/hydraulic Dual Hydrostatic Drive System.
9.110. Demonstrate an understanding of an open centered hydraulic control valve.
9.111. Demonstrate an understanding of the negative flow signal network.
9.112. Demonstrate an understanding of the pilot logic network.
9.113. Demonstrate an understanding of swashplate design NFC pumps.
9.114. Demonstrate an understanding of bent-axis design NFC pumps.
9.115. Demonstrate an understanding of side-by-side design NFC pumps.
9.116. Demonstrate an understanding of the operation of the power shift pressure pumps.
9.117. Remove and install a negative flow control relief valve on a hydraulic control valve.
9.118. Remove and install a proportional reducing valve.
9.119. Disassemble and assemble a negative flow control relief valve from a hydraulic control valve.
9.120. Disassemble and assemble a proportional reducing valve.

9.121. Test the NFC pressure on a machine.
9.122. Perform the power shift pressure sweep test.
9.123. Recalibrate a new proportional reducing valve for powershift pressure.
9.124. Test and adjust a pump using a flowmeter.
9.125. Adjust the pump NFC control using a flowmeter.
9.126. Demonstrate an understanding of using a hydraulic schematic.
9.127. Demonstrate an understanding of reading hydraulic system ISO symbols.
9.128. Demonstrate an understanding of electro-hydraulic implement system components.
9.129. Demonstrate an understanding of electro-hydraulic implement system operation.
9.130. Demonstrate an understanding of electro-hydraulic implement system calibration and diagnosis.
9.131. Remove and install an implement solenoid valve.
9.132. Remove and install an Electronic Control Module on a machine.
9.133. Calibrate the implement solenoid valves.
9.134. Calibrate the tilt linkage rack back position sensor.
9.135. Calibrate the lift linkage lift position sensor.
9.136. Calibrate sensors and proportional solenoid valves.
9.137. Calibrate a component when a new one is installed.
9.138. Test the current from the ECM to the pilot control valve solenoid.
9.139. Test the pilot or charge the pressure both upstream and downstream of the solenoid valve.

DET 10.0 — Vehicle Inspection

10.1. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of lighting systems.
10.2. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of safety systems.
10.3. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of engine systems.
10.4. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of chassis systems.
10.5. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of braking systems.
10.6. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of HVAC systems.
10.7. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of drivetrain systems.
10.8. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of driver and cab systems.
10.9. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of sleeper compartment systems.
10.10. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of coupling systems.
10.11. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of cooling systems.
10.12. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of auxiliary power systems.

10.13. Demonstrate knowledge and understanding of all aspects of performing a preventative maintenance inspection of electrical and electronic systems.

DET 11.0 — Failure Analysis

11.1. Identify the skills required to perform effective diagnostics.
11.2. Recognize the basic troubleshooting strategies commonly used to diagnose machine faults.
11.3. Identify and explain the troubleshooting process.
11.4. Demonstrate use of the troubleshooting process while diagnosing a machine fault.
11.5. Demonstrate an understanding of factory product performance responsibilities.
11.6. Demonstrate an understanding of customer product performance responsibilities.
11.7. Demonstrate an understanding of dealer product performance responsibilities.
11.8. Demonstrate an understanding of physical indicators of component problems.
11.9. Define failure analysis.
11.10. Demonstrate an understanding of basic metallurgy.
11.11. Demonstrate an understanding of component wear.
11.12. Demonstrate an understanding of component fractures.
11.13. Demonstrate an understanding of the applied failure analysis process.
11.14. Evaluate the effectiveness of the troubleshooting process used after a fault has been diagnosed and repaired.
11.15. Use the AFA process to identify types of threaded fastener failures and determine the root cause of failure.
11.16. Use the AFA process to identify types of engine bearing failures and determine the root cause of failure.
11.17. Use the AFA process to identify types of crankshaft failures and determine the root cause of failure.
11.18. Use the AFA process to identify types of engine valve failures and determine the root cause of failure.
11.19. Use the AFA process to identify types of piston, rings, and liner failures and determine the root cause of failure.
11.20. Use the AFA process to identify types of connecting rod failures and determine the root cause of failure.
11.21. Use the AFA process to identify types of turbocharger failures and determine the root cause of failure.
11.22. Use the AFA process to identify types of gear failures and determine the root cause of failure.
11.23. Use the AFA process to identify types of anti-friction bearing failures and determine the root cause of failure.
11.24. Use the AFA process to identify types of hydraulic pump and motor failures and determine the root cause of failure.
11.25. Use the AFA process to identify failures caused from lubrication problems.
11.26. Use the AFA process to identify types of shaft failures and determine the root cause of failure.
11.27. Use the AFA process to identify types of weld failures and determine the root cause of failure.
11.28. Use the AFA process to identify types of fractures and determine the root cause of failure.

11.29. Demonstrate an understanding of the AFA eight step process.
11.30. Demonstrate an understanding of basic metallurgy principles.
11.31. Use the AFA process to identify types of fractures.
11.32. Use the AFA process to determine the root cause of component fractures.
11.33. Use the AFA process to determine the root cause of component wear.
11.34. Demonstrate an understanding of the principles of visual examination.

DET 12.0 — Braking Systems

12.1. Demonstrate an understanding of band type brakes.
12.2. Demonstrate an understanding of shoe type brakes.
12.3. Demonstrate an understanding of caliper disc brakes.
12.4. Demonstrate an understanding of multiple disc brakes.
12.5. Demonstrate an understanding of brake hydraulic system basic components.
12.6. Demonstrate an understanding of the types of master cylinders.
12.7. Demonstrate an understanding of air operated brake systems.
12.8. Demonstrate an understanding of air over hydraulic brake systems.
12.9. Demonstrate an understanding of the retarder control system.
12.10. Demonstrate an understanding of the traction control system.
12.11. Manually release the park brake.
12.12. Charge the brake accumulators.
12.13. Remove and install drum type brakes.
12.14. Remove and install caliper type brakes.
12.15. Remove and install multiple disc type brakes.
12.16. Check the brake wear indicator.
12.17. Adjust the park brake cable.
12.18. Adjust the brake linkage.
12.19. Adjust the brake system slack adjusters.
12.20. Test and adjust the brake system air pressures.
12.21. Test and adjust the brake system hydraulic pressures.
12.22. Test the operation of the brake system.

DET 13.0 — Operator Environment

13.1. Demonstrate how to perform various tasks by navigating vehicle dash controls.
    13.1.1. Demonstrate how to navigate to onboard diagnostics.
    13.1.2. Demonstrate how to navigate to user settings.
    13.1.3. Demonstrate how to navigate to display settings.
13.2. Demonstrate basic functions of the malfunction switch in the operator environment.
13.3. Demonstrate basic understanding of how steering wheel controls communicate with other modules in the operator environment.
13.4. Demonstrate basic knowledge on how a blower motor controlled by climate control works in the operator environment.
13.5. Demonstrate basic knowledge on Electronic Logging Device (ELD).
    13.5.1. Navigate from the operator environment with understanding of Federal Mandate.
13.6. Demonstrate basic knowledge of Collision Mitigation Systems (CMS).
    13.6.1. Demonstrate functional alert systems and notifications in the operator environment.

13.7. Demonstrate basic knowledge of J1939 in the operator environment.
13.8. Demonstrate basic knowledge on how to diagnose and repair HVAC components.
13.9. Identify A/C hoses, lines, filters, and fittings.
13.10. Identify and inspect A/C compressor and evaporator.
13.11. Identify and inspect A/C condenser.
13.12. Identify and inspect heating and engine cooling components.
13.13. Identify and inspect the high-pressure switch.
13.14. Identify and inspect the receiver dryer.
13.15. Identify and inspect the expansion valve.
13.16. Inspect engine cooling and heating system hoses, lines, and clamps.
13.17. Identify and inspect the radiator, pressure cap, and coolant recovery system (surge tank).
13.18. Demonstrate functional alerts and notifications of the Electronic Stability Control (ESC) in the operator environment.

DET 14.0 — ASE Test

14.1. Demonstrate written knowledge by completing the ASE test.

DET 15.0 — SkillsUSA Framework

The SkillsUSA Framework is used to pinpoint the Essential Elements found in Personal Skills, Workplace Skills and Technical Skills Grounded in Academics. Students will be expected to display or explain how they used some of these Essential Elements. Please reference the graphic, as you may be scored on specific elements applied to your project. For more, visit: [www.skillsusa.org/who-we-are/skillsusa-framework/.](www.skillsusa.org/who-we-are/skillsusa-framework/)

COMMITTEE IDENTIFIED ACADEMIC SKILLS

The technical committee has identified that the following academic skills are embedded in this competition.

Math Skills

- Use fractions to solve practical problems.
- Use proportions and ratios to solve practical problems.
- Simplify numerical expressions.
- Solve practical problems involving percentages.
- Solve single variable algebraic expressions.
- Measure angles.
- Find surface area and perimeter of two-dimensional objects.
- Find volume and surface area of three-dimensional objects.
- Apply transformations (rotate or turn, reflect or flip, translate or slide and dilate or scale) to geometric figures.
- Make predictions using knowledge of probability.
- Make comparisons, predictions and inferences using graphs and charts.
- Organize and describe data using matrixes.

- Solve problems using proportions, formulas and functions.
- Find slope of a line.
- Use laws of exponents to perform operations.
- Solve practical problems involving complementary, supplementary and congruent angles.
- Solve problems involving symmetry and transformation.
- Find arc length and the area of a sector.

Science Skills

- Describe and recognize elements, compounds, mixtures, acids, bases and salts.
- Describe and recognize solids, liquids and gases.
- Describe characteristics of types of matter based on physical and chemical properties.
- Use knowledge of physical properties (shape, density, solubility, odor, melting point, boiling point, color).
- Use knowledge of chemical properties (acidity, basicity, combustibility, reactivity).
- Use knowledge of classification of elements as metals, metalloids and nonmetals.
- Describe and demonstrate simple compounds (formulas and the nature of bonding).
- Understand Law of Conservation of Matter and Energy.
- Describe phases of matter.
- Describe and identify physical changes to matter.
- Predict chemical changes to matter (types of reactions, reactants and products; and balanced equations).
- Use knowledge of potential and kinetic energy.
- Use knowledge of mechanical, chemical and electrical energy.
- Use knowledge of heat, light and sound energy.
- Use knowledge of temperature scales, heat and heat transfer.
- Use knowledge of sound and technological applications of sound waves.
- Use knowledge of the nature and technological applications of light.
- Use knowledge of speed, velocity and acceleration.
- Use knowledge of Newton's laws of motion.
- Use knowledge of work, force, mechanical advantage, efficiency and power.
- Use knowledge of simple machines, compound machines, powered vehicles, rockets and restraining devices.
- Use knowledge of principles of electricity and magnetism.
- Use knowledge of static electricity, current electricity and circuits.
- Use knowledge of magnetic fields and electromagnets.
- Use knowledge of motors and generators.

Language Arts Skills

- Provide information in conversations and in group discussions.
- Provide information in oral presentations.
- Demonstrate use of such verbal communication skills as word choice, pitch, feeling, tone and voice.

- Demonstrate use of such nonverbal communication skills as eye contact, posture and gestures using interviewing techniques to gain information.
- Analyze mass media messages.
- Demonstrate comprehension of a variety of informational texts.
- Use text structures to aid comprehension.
- Understand source, viewpoint and purpose of texts.
- Organize and synthesize information for use in written and oral presentations.
- Demonstrate knowledge of appropriate reference materials.
- Use print, electronic databases and online resources to access information in books and articles.
- Demonstrate narrative writing.
- Demonstrate expository writing.
- Demonstrate persuasive writing.
- Demonstrate informational writing.
- Edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure and paragraphing.

CONNECTIONS TO NATIONAL STANDARDS

State-level academic curriculum specialists identified the following connections to national academic standards.

Math Standards

- Numbers and operations
- Algebra
- Geometry
- Measurement
- Data analysis and probability
- Problem solving
- Reasoning and proof
- Communication
- Connections
- Representation

Source: *NCTM Principles and Standards for School Mathematics. For more information, visit: www.nctm.org.*

Science Standards

- Understands the structure and properties of matter
- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific inquiry
- Understands the scientific enterprise

Source: *McREL compendium of national science standards. To view and search the compendium, visit: http://www2.mcrel.org/compendium/.*

Language Arts Standards

- Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace.
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion and the exchange of information).

Source: *IRA/NCTE Standards for the English Language Arts. To view the standards, visit: www.ncte.org/standards.*