North Dakota Power Sports Education

Content Standards

Approved and Adopted - May 2016

North Dakota Department of Career and Technical Education
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Adapted from the Equipment and Engine Training Council School Accreditation Assessment Manual, 2013.

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This set of standards was approved and edited
by current North Dakota teachers of Power Sports
over a period of three months, through a cooperative process.

Career and Technical Education Standards Introduction

Mission

The mission of the State Board for Career and Technical Education (CTE) is to work with others to provide all North Dakota citizens with the technical skills, knowledge, and attitudes necessary for successful performance in a globally competitive workplace.

Vision

The State Board for Career and Technical Education (CTE) is committed to providing career awareness, work readiness skills, occupational preparation, and retraining of workers throughout the state. Career and technical education will span all educational levels, providing youth with exploration opportunities and the foundation skills needed to enter the world of work while providing adults with skills needed to enter, re-enter, or advance in the workforce.

Goal

North Dakota Career and Technical Education's goal is to create a competitive and knowledgeable work force. This is accomplished through a variety of educational program areas that are organized to prepare students for careers in their chosen fields, to take leadership roles, and balance their multiple roles in life. CTE programs prepare students with the knowledge and skills to make informed career choices, to integrate and apply academic concepts, to prepare for successful participation in a global society, and to engage in lifelong learning.

Standards Development Process

Standards development is a multi-phase process. Existing and/or industry standards are the basis for the North Dakota Program Standards. A team of expert secondary and postsecondary teachers, business and industry representatives, and the state program supervisor draft the standards document. Once the document is finalized, the State Board for Career and Technical Education approves and adopts the standards.

Course Frameworks are also developed by the writing team. A framework includes a brief overview of the course content, topical units of study, and identifies the standards recommended for inclusion within the course. The frameworks are tailored to prepare young people for the opportunities in North Dakota. School Districts will use the frameworks as a guide for developing curriculum that reflects local needs.

Key Principles of Career and Technical Education

We believe that Career Technical Education:

1. **Draws its curricula, standards, and organizing principles from the workplace.**
   The workplace provides the context, objectives, and organizing constructs for instruction and assessment. The workplace also defines the standards of performance necessary, including those required for academic, technical, and employability skills.

2. **Is a critical and integral component of the total educational system, offering career-oriented benefits for all students.**
   CTE classes offer educational benefits to students pursuing careers requiring specific technical skills as well as providing a strong foundation for those pursuing a traditional four-year (or more) degree.

3. **Is a critical and integral component of the workforce development system, providing the essential foundation for a thriving economy.**
   Preparation of a well-prepared, qualified workforce requires solid academics, good work ethics, and specific technical skills as well as the ability to communicate, work with others, solve problems, and use information. CTE contributes directly to this preparation by providing a curriculum tied to specific workplace requirements.

4. **Maintains high levels of excellence supported through identification of academic and workplace standards, measurement of performance (accountability), and high expectations for participant success.**
   Career Technical Education is committed to continuous improvement, attention to industry certification, and the development of highly qualified teachers.

5. **Is robust and flexible enough to respond to the needs of the multiple educational environments, customers, and levels of specialization.**
   CTE involves a large and complex delivery system that (1) integrates career exploration, (2) provides effective tools for organizing all curricula, (3) facilitates the teaching and use of technology, (4) is integrated into the total learning experience, (5) enhances the learning of academic subjects, (6) teaches broad occupational skills, (7) includes all aspects of the industry, (8) teaches how to balance family and work responsibilities, (9) provides job-specific training, (10) is offered at multiple levels of the educational continuum, and (11) is delivered through a variety of educational environments.

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Standard 1	SHOP SAFETY, PRACTICES, TOOLS, AND TROUBLESHOOTING	
Topic 1.1	**Work Habits**	
	Student Competencies	
	1.1.1	Demonstrate the proper lifting and blocking of equipment.
	1.1.2	Demonstrate the safe usage of all service shop tools.
Topic 1.2	**Work Environment**	
	Student Competencies	
	1.2.1	Maintain a clean and safe work environment.
	1.2.2	Maintain clean tools and equipment.
Topic 1.3	**Personal Safety**	
	Student Competencies	
	1.3.1	Demonstrate safe work habits by wearing approved eye, hearing, and skin protection.
	1.3.2	Demonstrate safe work habits by using approved safety and personal protection equipment.
	1.3.3	Describe personal safety practices relating to personal clothing, jewelry, shoes, and proper behavior in the workplace.
	1.3.4	Recognize industry-accepted procedures for using proper safety devices, including lock-out/tag-out.
Topic 1.4	**Emergency Awareness**	
	Student Competencies	
	1.4.1	Demonstrate the proper use of fire extinguishers.
	1.4.2	Recognize emergency evacuation procedures, apply fire safety awareness, and describe safety precautions to prevent fires.
Topic 1.5	**Regulations**	
	Student Competencies	
	1.5.1	Recognize the use of safety color codes.
	1.5.2	Identify hazard communication labels and symbols.
	1.5.3	Explain Material Safety Data Sheet (MSDS) purpose, use, and location.
	1.5.4	Describe hazardous materials safe handling and disposal as required by EPA local ordinance.
	1.5.5	Recognize and observe industry and OSHA, federal and state safety and environmental rules.
Topic 1.6	**Shop Practices**	
	Student Competencies	
	1.6.1	Document service work on work orders.
	1.6.2	Document parts and shop supplies on shop inventory lists and work orders.
	1.6.3	Complete various OEM warranty forms (electronic or paper).

Topic 1.7	**Technical Publications**	
	Student Competencies	
	1.7.1	Describe types of service and parts manual formats and their applications.
	1.7.2	Demonstrate the ability to use and interpret reference manuals and materials correctly.
	1.7.3	Recognize industry-specific terminology as well as demonstrate proper usage of labor time guides and flat rate time.
	1.7.4	Look up parts using paper and electronic parts and service look-up systems (CD-ROM) and the Internet.
Topic 1.8	**Service Tools and Equipment**	
	Student Competencies	
	1.8.1	Demonstrate the proper and safe use of all tools.
	1.8.2	Clean tools and return them to proper storage areas.
Topic 1.9	**Hand Tools**	
	Student Competencies	
	1.9.1	Identify basic hand tools.
	1.9.2	Demonstrate the proper use of hand tools.
	1.9.3	Demonstrate the proper care and storage for hand tools.
Topic 1.10	**Precision Measuring Tools**	
	Student Competencies	
	1.10.1	Identify, care for, and store measuring tools.
	1.10.2	Make accurate measurements.
	1.10.3	Demonstrate the use of the following tools: micrometer, dial indicator, bore gauge, feeler gauge, caliper, compression gauge, vacuum gauge, pressure gauge, digital multimeter, tachometer (analog or digital).
	1.10.4	Identify torque wrench styles.
	1.10.5	Demonstrate the proper use, maintenance, and calibration requirements of torque wrenches.
	1.10.6	Demonstrate understanding of the manufacturer's torque values and where to find the specification.
	1.10.7	Demonstrate the following torque methods and procedures: incremental torque and break-away torque.
Topic 1.11	**Additional Shop Tools**	
	Student Competencies	
	1.11.1	Identify the various types of lifting and hoisting equipment.
	1.11.2	Demonstrate proper and safe use of hydraulic tools used by technician: hydraulic presses and hydraulic pullers.
	1.11.3	Identify basic cleaning equipment.
	1.11.4	Demonstrate the proper and safe use of cleaning equipment for washing parts and components of machines, including: solvent tank, pressure washer, and steam cleaner. The student can also demonstrate the proper and safe disposal of cleaning materials based on EPA and local regulations.

Topic 1.12	**Troubleshooting Methods**	
	Student Competencies	
	1.12.1	Demonstrate an understanding in principles of troubleshooting by identifying systems and components, understanding sequence of events in system, and accessing technical manuals to find technical information and specifications.
Topic 1.13	**Information Gathering for Troubleshooting Purposes**	
	Student Competencies	
	1.13.1	Interview the customer and/or the operator for information.
	1.13.2	Identify exact symptoms.
	1.13.3	Accurately separate systems.
	1.13.4	Make a complete physical examination of the product.
	1.13.5	Replicate or simulate a given problem.
	1.13.6	Determine and classify all symptoms.
	1.13.7	Perform specific tests using tools to determine which components are working correctly.
	1.13.8	Record the results on a worksheet.
	1.13.9	Make repairs, and then retest to verify the repair.
	1.13.10	Communicate with the customer regarding the cause and the prevention of future problems.

Standard 2	TWO- AND FOUR-STROKE GASOLINE ENGINES	
Topic 2.1	**Engine Identification**	
	Student Competencies	
	2.1.1	Identify a manufacturer's model number, serial number, and type number for two- and four-stroke engines.
Topic 2.2	**Two-Stroke Engine Fundamentals**	
	Student Competencies	
	2.2.1	Explain two-stroke engine operating theory.
	2.2.2	Explain piston ported type and reed valve type and stratified charge engine operation.
	2.2.3	Describe the normal combustion process, detonation and its effects, pre-ignition and its effects.
	2.2.4	Identify two-stroke components and parts and explain their purpose.
Topic 2.3	**Four-Stroke Engine Fundamentals**	
	Student Competencies	
	2.3.1	Explain four-stroke engine operating theory.
	2.3.2	Describe the normal combustion process, detonation and its effects, pre-ignition and its effects.
	2.3.3	Identify four-stroke components and parts and explain their purpose.
Topic 2.4	**Fundamental Engine Components**	
	Student Competencies	
	2.4.1	Describe engine block purpose, nomenclature, and function.
	2.4.2	Describe crankcase, cylinder, and cylinder head nomenclature and function.
	2.4.3	Describe piston, piston pin and piston rings and types and proper assembly.
	2.4.4	Describe connecting rod, bearings, and crankshaft nomenclature and function.
	2.4.5	Describe engine bearing types, oil seal types, and service application.
	2.4.6	Describe crankshaft types and service application.
	2.4.7	Describe valve train and valve retainer types nomenclature and function.
	2.4.8	Demonstrate an understanding of crankshaft angle and valve timing degrees.
	2.4.9	Describe "valve overlap" and its function.
	2.4.10	Describe lubrication systems nomenclature and function.
	2.4.11	Describe the purpose of an ignition system and its nomenclature and function.
	2.4.12	Identify the components and function of a battery ignition system.
	2.4.13	Identify the components and function of an electronic ignition system.
	2.4.14	Identify the components and function of a magneto ignition system.
	2.4.15	Understand the concept of heat transfer and the purpose of a cooling system.
	2.4.16	Define the major types of cooling systems used on power equipment.

	2.4.17	Describe air-cooled system nomenclature and function.
	2.4.18	List major causes of air-cooled engine overheating.
	2.4.19	Describe normal service procedures performed on an air-cooled engine.
	2.4.20	Describe the advantages and disadvantages of a liquid-cooled engine.
	2.4.21	Identify the components and function of a liquid-cooled engine.
	2.4.22	Properly pressure test a liquid-cooled system.
	2.4.23	List major causes of cooling system failures on a liquid-cooled engine.
	2.4.24	Describe normal service procedures performed on a liquid-cooled engine.
	2.4.25	Identify the basic types of fuel systems used in power equipment.
	2.4.26	Identify the function of each component in the fuel system, including carburetor, fuel filter, fuel lines, fuel pump, electronic fuel injector, and ventilation.
	2.4.27	Describe the type, nomenclature and function of vacuum-feed, diaphragm, float, rotary, and slide valve carburetors.
	2.4.28	Identify and describe the idle circuit and the main circuit.
	2.4.29	Explain the venture principle, variable venturi carburetors, and terms.
	2.4.30	Describe enrichment devices, including choke types, purging systems, and primer types.
	2.4.31	Describe the function of a fixed orifice jet, high speed nozzle, emulsion tube, and purging system.
	2.4.32	Explain the purpose of a fuel filter.
	2.4.33	Identify the common types of fuel filters and describe the difference between micron, mesh, gravity, and pressure.
	2.4.34	Identify the common types of fuel pumps (vacuum, mechanical, and electronic) and describe fuel pump nomenclature and function.
	2.4.35	Describe accelerator pump nomenclature and function.
	2.4.36	Explain the theory, function, and components of electronic fuel injection (EFI).
	2.4.37	Explain the theory, function, and components of gaseous fuels.
	2.4.38	Describe air filter nomenclature and function.
	2.4.39	List a minimum of five types of air filters used on small engines.
	2.4.40	Describe the normal service procedures performed on each type of air filter system.
	2.4.41	Describe exhaust system nomenclature and function as well as types and terms associated with exhaust systems.
	2.4.42	Describe the theory and function of a single stage catalyst (catalytic converters).
	2.4.43	Describe the proper service cleaning procedures for exhaust ports and spark arrester screens.
	2.4.44	Describe engine starting systems nomenclature and function.
	2.4.45	Identify the components of a recoil starting system and describe the function of each.
	2.4.46	Identify and describe the function of each component of a DC electric starting system.
	2.4.47	Identify the components of an AC electric starting system and describe the function of each.
	2.4.48	Describe the operation of a break-away clutch used on AC and DC electric starter motors.
	2.4.49	Perform 12-volt DC starter motor current draw test.

	2.4.50	Remove and replace a starter motor and remove, test, and replace a starter relay (solenoid).
	2.4.51	Identify terminals and connectors used in electrical systems.
	2.4.52	Explain electrical/electronic terms that are common to the power equipment industry.
	2.4.53	Identify types of charging systems including under flywheel alternator and belt drive alternator.
	2.4.54	Describe a DC amps test and an AC volts test.
	2.4.55	Describe the function of a diode and testing procedure.
	2.4.56	Describe a resistance test.
	2.4.57	Perform current drain test using a DC shunt or equivalent and can remove and replace a regulator/rectifier.
	2.4.58	Describe series circuit and parallel circuit, and explain different types of circuit failures.
	2.4.59	Demonstrate applicable test procedures for testing series and parallel circuits.
	2.4.60	Check continuity in circuits and electrical system components.
	2.4.61	Check current flow in electrical systems and components.
	2.4.62	Inspect, test, and replace fusible links, fuses, and circuit breakers.
	2.4.63	Identify electrical wire sizes (AWG) and selection based on anticipated current load.
	2.4.64	Identify sending units used in an electrical circuit and explain their function.
	2.4.65	Demonstrate safe work habits when working with electrical/charging systems and circuits.
	2.4.66	Explain storage battery theory and operation.
	2.4.67	Remove, clean, and replace battery, perform specific gravity test on battery cell electrolyte, and determine battery state of charge using digital multimeter.
	2.4.68	Explain proper procedure for battery disposal based on EPA and local ordinance.
	2.4.69	Identify the purpose of the governor system.
	2.4.70	Describe governor system nomenclature and function, including pneumatic (air vane), mechanical, and electronic.
	2.4.71	Perform dynamic governor adjustments.
Topic 2.5	**Lubrication Fundamentals**	
	Student Competencies	
	2.5.1	Describe the theory of lubrication and the differences between two and four-stroke.
	2.5.2	Describe general API oil ratings.
	2.5.3	Describe the meaning of SAE viscosity ratings.
	2.5.4	Describe the classification of two-stroke oils.
	2.5.5	Describe ISO/LEG two stroke oil standard, A, B, C, and D.
	2.5.6	Describe JASO oil standard, classification FA, FB, FC, FD.
	2.5.7	Describe NEMA (BIA) oil standard classification TC, TCW-1, 2, and 3.
	2.5.8	List common oil contaminants.
	2.5.9	Identify types of oil filters used on power equipment.
	2.5.10	State guidelines for selecting and using oils.

Topic 2.6	Lubrication - Engine Maintenance	
	Student Competencies	
	2.6.1	Describe types of lubrication systems for either two- or four-stroke engines and identify terms associated with an engine lubrication system.
	2.6.2	List the functions of engine oil.
	2.6.3	Interpret engine oil application charts used in owner's/operator's manuals.
	2.6.4	Prepare pre-mixed fuel for a two-stroke engine.
	2.6.5	Describe potential problems resulting from improper oil/fuel mixtures.
	2.6.6	Describe potential lubrication issues resulting from use of alcohol blended fuels.
	2.6.7	Describe splash lubrication systems and pressure lubrication systems.
	2.6.8	Describe oil filtration system.
	2.6.9	Describe methods of checking oil level in an engine.
	2.6.10	Change engine oil and filter on a variety of selected equipment.
	2.6.11	List the benefits of positive crankcase ventilation.
	2.6.12	Identify the components and function of a crankcase ventilation breather assembly.
	2.6.13	Service a crankcase breather assembly.
Topic 2.7	**Cooling System - Engine Maintenance**	
	Student Competencies	
	2.7.1	Describe proper cooling system cleaning methods.
	2.7.2	Perform cooling system cleaning for air-cooled engine.
	2.7.3	Perform cooling system flush and cleaning of liquid-cooled engine.
	2.7.4	Demonstrate, remove, and replace a water pump, and remove and replace a thermostat.
Topic 2.8	**Fuel System - Engine Maintenance**	
	Student Competencies	
	2.8.1	Identify types (E10, E15, E20, and E85) and grades (85, 87, 89, and 93 octane) of gasoline used in power equipment.
	2.8.2	Describe the use of a fuel additive for storage.
	2.8.3	Describe the proper method of carburetor cleaning.
	2.8.4	Remove and replace a carburetor on a small gasoline engine.
	2.8.5	Disassemble, clean, and reassemble carburetors.
	2.8.6	Install a repair kit in a carburetor and inspect internal carburetor parts for wear.
	2.8.7	Adjust carburetor choke linkage.
	2.8.8	Adjust carburetor mixture and throttle settings per EPA/CARB emission regulations.
	2.8.9	Adjust the carburetor float level and metering lever.
	2.8.10	Inspect, remove, replace, and repair fuel lines/hoses and filters.
	2.8.11	Inspect, remove, and replace the fuel tank cap and vent.

Topic 2.9	**Start System - Engine Maintenance**	
	Student Competencies	
	2.9.1	Repair three different styles of rewind starters.
	2.9.2	Replace a starter drive gear.
	2.9.3	Disassemble and reassemble 12-volt DC and 120-volt AC starter motor including high pot testing.
Topic 2.10	**Exhaust System - Engine Maintenance**	
	Student Competencies	
	2.10.1	Describe problems that can occur from operating equipment with a removed or damaged exhaust system.
	2.10.2	State the danger of operating power equipment in an enclosed area.
	2.10.3	Describe the purpose of an exhaust deflector and the purpose of a spark arrester screen.
Topic 2.11	**Test a Two-Stroke Engine**	
	Student Competencies	
	2.11.1	Check an engine for top end/ compression.
	2.11.2	Inspect the fuel system for proper operation by performing a carburetor pressure test.
	2.11.3	Check an engine for base/primary compression (bottom end).
	2.11.4	Inspect the ignition system for proper operation by performing a three-point spark test.
	2.11.5	Inspect the exhaust port for carbon obstruction.
	2.11.6	Check crankcase integrity with a pressure/vacuum pump.
	2.11.7	Operate the engine to check for proper starting and power output under load.
	2.11.8	Viewed videos/manuals and understands the importance of power equipment safety.
	2.11.9	Demonstrate power equipment safety practices.
	2.11.10	Demonstrate understanding of cutting attachment operation, replacement, and sharpening for a rotary blade, saw chain, hedge trimmer, etc.
	2.11.11	The student can explain ANSI safety standards and requirements regarding kickback, operator presence, etc.
	2.11.12	Given a two-stroke engine on a product with trouble symptoms installed, the student can solve the problem by using the proper manual and tools.
Topic 2.12	**Two-Stroke Engine Disassembly, Inspection, and Repair**	
	Student Competencies	
	2.12.1	Disassemble an engine and inspect, measure, service, and repair components.
	2.12.2	Remove, service, and replace an exhaust system.
	2.12.3	Remove the cylinder and demonstrate de-carboning techniques.
	2.12.4	Remove and inspect the connecting rod and piston, remove and inspect the crankshaft, remove and replace needle bearings, remove and replace main ball bearings, and inspect, measure, service, or replace all components.
	2.12.5	Demonstrate two-stroke piston ring installation and demonstrate two-stroke piston ring groove cleaning.

	2.12.6	Inspect reed valves.
	2.12.7	Inspect the intake side of the piston skirt on piston-ported engine valves.
	2.12.8	Repair damaged threads using a thread repair device.
	2.12.9	Inspect and repair the recoil starter system.
	2.12.10	Inspect and service various clutch designs.
Topic 2.13	**Four-Stroke Gasoline Engine Diagnosis**	
	Student Competencies	
	2.13.1	Check the fuel pump pressure.
	2.13.2	Pressure test a carburetor.
	2.13.3	Operate the engine to check for proper starting and acceleration.
	2.13.4	Differentiate a hunting/surging symptom between the fuel system and the governor system.
	2.13.5	Perform a cylinder balance test and demonstrate understanding of findings.
	2.13.6	Perform a cylinder leak down test.
	2.13.7	Perform an engine crankcase vacuum test.
	2.13.8	Perform an oil pressure test.
	2.13.9	Test an ignition system using an adjustable three-point spark tester.
	2.13.10	Understands the effect of a partially sheared flywheel key on both breaker point and electronic ignition systems.
	2.13.11	Remove, inspect, and replace points and the condenser.
	2.13.12	Test a capacitive discharge ignition system.
	2.13.13	Test an ignition armature assembly.
	2.13.14	Remove and replace an ignition armature (ignition coil, ignition module) and properly set the ignition coil air gap.
	2.13.15	Test and replace high tension leads.
	2.13.16	Test solid state transistor controlled (TCI) one- and two-piece systems.
	2.13.17	Test a capacitive discharge ignition system.
	2.13.18	Demonstrate the timing procedure for points style.
	2.13.19	Demonstrate the timing procedure for solid state/electronic style.
	2.13.20	Measure primary and secondary resistance.
	2.13.21	Check/replace an engine ignition stop switch.
	2.13.22	Inspect the cooling system.
	2.13.23	Check for damage to the fins or fan.
	2.13.24	Identify debris clogging air fins.
	2.13.25	Describe the proper assembly of an air intake system assembly.
	2.13.26	Remove and replace the intake manifold.
	2.13.27	Solve the problem by using the proper manual and tools, given a four-stroke engine on a product with trouble symptoms installed.

Topic 2.14	Four-Stroke Gasoline Engine Service	
	Student Competencies	
	2.14.1	Disassemble and inspect hydraulic or mechanical lifters.
	2.14.2	Inspect the valve train, including valves, rocker arms, lifters, studs, and push rods.
	2.14.3	Replace valve stem seals; inspect valve guides for wear; inspect, resurface or replace valve seats; and perform valve lapping operation and explain why.
	2.14.4	Inspect and measure a cylinder bore, remove a ridge from a cylinder bore, and de-glaze and clean the cylinder bore using a rigid hone.
	2.12.5	Demonstrate understanding of OEM cylinders reuse specifications.
	2.14.6	Inspect and measure camshaft bearings for wear and damage.
	2.14.7	Inspect the valve train, including valves, rocker arms, lifters, studs, and push rods.
	2.14.8	Inspect the balance system and inspect shaft(s) and support bearings for damage and wear.
	2.14.9	Measure and determine values for engine bearings using precision measurement tools and OEM specifications.
	2.14.10	Use Plastigage to determine bearing clearances in an engine.
	2.14.11	Install all engine components, assemblies and gaskets and tighten fasteners according to manufacturer's specifications and procedures.
	2.14.12	Install the crankshaft with its bearings.
	2.14.13	Measure crankshaft end play and measure crankshaft run-out.
	2.14.14	Verify camshaft timing according to manufacturer's specifications and procedure.
	2.14.15	Adjust valves (mechanical and hydraulic lifters).
	2.14.16	Assemble and test run the engine.
	2.14.17	Measure and determine values for engine bearings.
	2.14.18	Demonstrate initial start-up procedures.
	2.14.19	Demonstrate static governor adjustment.
	2.14.20	Check top no-load speed.
	2.14.21	Check all safety-related devices for proper operation, correct all problems, and provide written documentation of safety device failures to the customer and manufacturer.
	2.14.22	From written documentation from the work order, inform the customer of problems related to maximum engine life and future methods of failure prevention.
Topic 2.15	**Two- And Four-Stroke Gasoline Engines Failure Analysis**	
	Student Competencies	
	2.15.1	Classify failures into five major categories: dirt, heat, fuel, lubrication, and mechanical.
	2.15.2	Identify the effects of abrasive ingestion on engine components.
	2.15.3	Accurately identify the entrance path of abrasives on several engine failure examples.
	2.15.4	Identify the effects of insufficient lubrication on engine components (piston cylinders, etc.)

	2.15.5	Accurately define the cause of failure on several engine failure examples.
	2.15.6	Accurately identify two-stroke lubrication/fuel quality failure root cause.
	2.15.7	Identify the use of incorrect or no lubricant.
	2.15.8	Identify and describe engine failures caused by stale fuel.
	2.15.9	Identify the effects of overheating on engine component parts.
	2.15.10	Identify overheating effects on two-stroke engines due to poor exhaust system maintenance, such as, piston carbon scoring.
	2.15.11	Define detonation, preignition and effects on engine components.
	2.15.12	Identify two-stroke engine failure caused by lean mixture.
	2.15.13	Identify the effects of over speeding on engine component parts.
	2.15.14	Identify the signature break on a connecting rod on several engine failure examples.
	2.15.15	Identify exhaust port piston scoring and large end connecting rod bearing failures due to over speeding.
	2.15.16	Identify the effects of excessive vibration on engine block and mounting base.
	2.15.17	Given a sample of various failed components, identify the symptoms, types and causes of the failures.

Standard 3	ELECTRICAL	
Topic 3.1	**Electrical Theory**	
	Student Competencies	
	3.1.1	Demonstrate understanding of current flow in a circuit.
	3.1.2	Define electrical terms.
	3.1.3	Demonstrate understanding of the relationship between magnetism and electrical flow.
	3.1.4	Explain sources and uses of electricity.
	3.1.5	Discuss the difference between a conductor and an insulator.
	3.1.6	Identify the basic electrical measurements used in OPE, including volts, amperes (amps), and ohms.
	3.1.7	Demonstrate understanding of the nomenclature and function of electrical systems.
	3.1.8	Identify electrical symbols used on wiring diagrams and schematics.
	3.1.9	Demonstrate the ability to read OPE wiring diagrams.
	3.1.10	Draw a circuit diagram of a variety of selected equipment using correct symbols.
	3.1.11	Explain how to measure current, voltage, and resistance.
	3.1.12	Demonstrate the correct use of a digital multimeter.
	3.1.13	Demonstrate a performance load test on 12-volt batteries.
	3.1.14	Describe characteristics of electrical circuits.
	3.1.15	Diagram basic electrical circuits, including series, parallel, and series-parallel.
	3.1.16	Identify integrated circuit devices and explain their function.
	3.1.17	Explain the different kinds of circuit failures.
	3.1.18	Identify electrical/electronic circuit protection devices and explain their function.
	3.1.19	Identify electrical circuit components and explain their function in electrical circuits.
	3.1.20	Demonstrate the correct test procedures used to locate opens, shorts, and grounds.
	3.1.21	Repair wire harness with various types of wire connectors and terminals.
	3.1.22	Identify normally open/closed switch types.
	3.1.23	Demonstrate the test and repair procedures of interlock safety switches.
	3.1.24	Describe design, construction, and operation of lead acid batteries.
	3.1.25	Explain how storage batteries are constructed and how cells are connected to produce voltage.
	3.1.26	Explain the common methods of rating batteries.
	3.1.27	Describe the correct method using a battery for jump-starting.
	3.1.28	Explain the elements of AC and DC charging systems.
	3.1.29	Describe charging system theory of operation.
	3.1.30	Demonstrate methods of testing charging circuits.

	3.1.31	Explain charging system rectification.
	3.1.32	Describe voltage regulation.
	3.1.33	Remove and replace starter motors.
	3.1.34	Identify and correct signs of corrosion in an electrical system.
	3.1.35	Demonstrate the application of dielectric grease on electrical connections.
	3.1.36	Check continuity in electrical/electronic circuits, components, and parts.
	3.1.37	Check applied voltages, circuit voltages, and voltage drops.
	3.1.38	Check current flow.
	3.1.39	Inspect, test, and replace fusible links, circuit breakers, and fuses.
	3.1.40	Inspect, test, and replace diodes, resistors, and capacitors.
	3.1.41	Remove and replace underflywheel alternator.
	3.1.42	Test and replace starter relay and solenoids.
	3.1.43	Diagnose basic electrical circuit problems.
	3.1.44	Demonstrate key-off power drain test using DC shunt.
	3.1.45	Given an electrically operated component or system with trouble symptoms installed, Solve the problem using the proper manual and tools.

Standard 4	DRIVELINES/HYDRAULICS/HYDROSTATICS	
Topic 4.1	**Hydraulic System Principles**	
	Student Competencies	
	4.1.1	Identify types of hydraulic systems commonly found on power equipment.
	4.1.2	Identify hydraulic system component parts and function.
	4.1.3	Interpret simple hydraulic system symbols, schematics, and diagrams.
	4.1.4	Identify different types of hydraulic fluids.
	4.1.5	Identify different types of hydraulic hoses, lines, and fittings.
Topic 4.2	**Hydraulic System Safety**	
	Student Competencies	
	4.2.1	Demonstrate the use of the personal protective equipment required for the safe use of hydraulic testing equipment.
	4.2.2	Explain the dangers of working with hydraulic fluids under pressure.
	4.2.3	Demonstrate the safe method for checking for hydraulic system leaks.
	4.2.4	Demonstrate the use and importance of lock-out tags when servicing hydraulic systems.
Topic 4.3	**Hydraulic Component Theory**	
	Student Competencies	
	4.3.1	Demonstrate understanding of nomenclature and terms used in hydraulic systems.
	4.3.2	Demonstrate understanding of the function of a reservoir, pump, relief valve, control valve, and cylinder in relation to each other.
	4.3.3	Demonstrate an understanding of hydrostatic theory.
	4.3.4	Explain the purpose of a charge circuit.
	4.3.5	Explain the differences between hydraulic and hydrostatic systems.
	4.3.6	Select the proper hydraulic fluid for specific systems.
	4.3.7	Demonstrate an understanding of the nomenclature and function of filters, including micron or mesh rating and types of filters.
	4.3.8	Demonstrate understanding of the nomenclature and function of hydraulic pumps.
	4.3.9	Define the difference between fixed-displacement and variable-displacement pumps.
	4.3.10	Demonstrate the ability to follow oil flow through each pump with/ without hydraulic function.
	4.3.11	Demonstrate understanding of nomenclature and function of control valves.
	4.3.12	Demonstrate understanding of the function of hydraulic valves.
	4.3.13	Demonstrate understanding of the nomenclature and function of fittings, including the proper identification of threaded, pitched, tapered, and straight.

	4.3.14	Identify fittings/thread styles. Examples, O-ring boss, NPT, NPTF, metric, JIC, British standard, parallel and straight, O-ring flange, ORFS.
	4.3.15	Describe the construction of hoses and steel lines, and their uses.
	4.3.16	Describe procedures for repairing damaged threads.
	4.3.17	Demonstrate understanding of the identification, nomenclature, and function of cylinders.
	4.3.18	Identify a single acting cylinder, name parts and function and follow the oil flow through the cylinder.
	4.3.19	Identify a double-acting cylinder, name all parts, and follow the oil flow through the cylinder.
	4.3.20	Describe normal service procedures performed on cylinders.
	4.3.21	Demonstrate an understanding of the types of hydrostatic transmissions.
	4.3.22	Demonstrate an understanding of the nomenclature and function of all types of hydrostatic transmissions, including gear, axial piston, swash plate, and cam lobe.
	4.3.23	Identify lubrication circuits, including pump, motor, forward, neutral, and reverse.
	4.3.24	Identify hydrostatic drive system components.
	4.3.25	Identify and describe hydrostatic drive system component function.
	4.3.26	Identify the power transfer from the engine to the ground drive on a hydrostatic unit.
	4.3.27	Describe normal service operations performed on hoses and fittings.
	4.3.28	Inspect, remove, and replace a hydrostatic drive unit mechanism (belt, chain, and direct coupling).
	4.3.29	Replace a hydrostatic filter.
	4.3.30	Inspect, remove, and replace a hydrostatic drive unit.
Topic 4.4	**Hydraulic System Service Procedures**	
	Student Competencies	
	4.4.1	Check reservoir fluid level.
	4.4.2	Perform basic hydraulic system tests (e.g., pressure and flow).
	4.4.3	Test hydraulic cylinder operation.
	4.4.4	Inspect, remove, and replace various hoses, fittings, oil coolers, lines, and couplings.
	4.4.5	Perform OEM-required maintenance on a system.
	4.4.6	Remove/replace a hydraulic oil cooler.
	4.4.7	Demonstrate safe working habits when servicing hydraulic systems.
	4.4.8	Identify basic hydraulic tools.
	4.4.9	Show the proper and safe use of various types of hydraulic test equipment, including gauges and flow rating equipment.
	4.4.10	Identify various types of hydraulic test equipment and accessories required for proper testing.
	4.4.11	Demonstrate the proper care, maintenance, and storage of each piece of testing equipment.
	4.4.12	Inspect hydraulic systems, fluid levels, and leaks.
	4.4.13	Inspect filters, pressure lines, cylinders, and suction lines.

	4.4.14	Inspect control valves and linkages.
	4.4.15	Diagnose hydraulic system leaks and noises.
	4.4.16	Perform hydraulic system performance tests.
	4.4.17	Pressure test with gauges.
	4.4.18	Perform a hydrostatic drive performance test and determine repair requirements.
	4.4.19	Check system filters and fluid.
	4.4.20	Perform specific pressure tests.
	4.4.21	Check, remove, repair, replace, and adjust hydrostatic drive controls and can adjust neutral position.
	4.4.22	Test, remove, repair, and/or replace a hydrostatic drive unit and determine the cause of failure.
	4.4.23	Check the reservoir fluid level.
	4.4.24	Perform a hydrostatic performance test and define symptoms.
	4.4.25	Inspect, remove, and replace a hydrostatic drive linkage mechanism.
	4.4.26	Perform OEM maintenance service procedures.
	4.4.27	Given a hydraulically operated product with trouble symptoms installed, solve the problem with the use of the proper manual and tools.
Topic 4.5	**Driveline Fundamentals**	
	Student Competencies	
	4.5.1	Identify types of PTO couplings, including rigid, flexible, mechanical flexible, and material flexible.
	4.5.2	Remove, repair, and replace various PTO couplings.
	4.5.3	Describe belt drive operation.
	4.5.4	Identify types of drive belts common to OPE industry, including fractional horsepower V-belt, double angle V-belt, timing belt, molded belt, and notched belts.
	4.5.5	Define belt drive terms, including creep, stretch, wedge, and whipping.
	4.5.6	Remove, adjust, and replace belt drives.
	4.5.7	Properly adjust drive belts.
	4.5.8	Describe variable-speed pulley belt drive operation.
	4.5.9	Demonstrate proper belt location and adjustment of variable-speed pulley drive belts.
	4.5.10	Identify chain styles used in OPE industry, including roller, pin link, and silent.
	4.5.11	Demonstrate proper chain drive maintenance.
	4.5.12	Repair broken or damaged chain using master link.
	4.5.13	Describe the operation of an electro-magnetic clutch.
	4.5.14	Demonstrate proper air gap adjustment on an electro-magnetic clutch.
	4.5.15	Remove and install an electro-magnetic clutch assembly.
	4.5.16	Identify different styles of transaxles and transmissions.
	4.5.17	Describe the power flow through the transaxle/transmission from input shaft to output shaft.

	4.5.18	Remove and replace transaxle/transmission assemblies.
	4.5.19	Disassemble, diagnose and re-assemble transaxle/transmission assemblies.
	4.5.20	Identify different styles of transmissions.
	4.5.21	Remove and replace a transmission assembly.
	4.5.22	Disassemble and assemble a transmission assembly.

Standard 5	GENERATORS	
Topic 5.1	**Generator Basics**	
	Student Competencies	
	5.1.1	Demonstrate understanding of the function of various types of generators.
	5.1.2	Explain electromagnetic principles, including magnetic fields, electromagnetic relationships, permanent magnets, and electromagnetic forces.
	5.1.3	Explain electric power generation, including electric power systems and generator construction, including single voltage, dual voltage, single phase, and three phase.
	5.1.4	Explain excitation systems, including brushless, direct, automatic voltage control of generators, frequency, total harmonic distortion, power factor, AC system, and DC system.
	5.1.5	Explain differences in types of loads, including resistive loads, reactive loads, including inductive reactance and capacitive reactance.
	5.1.6	Explain units of electrical measurement, including ampere units of current flow, voltage unit of pressure, ohm unit of resistance, Ohm's law, and watt unit of electrical power.
	5.1.7	Locate and identify generator components, including winding resistance, shorts and opens, capacitors, transformers, rectifiers, including rectifier operation, full wave rectifier, silicone controlled rectifier, the zener diode, and brushes.
	5.1.8	Locate and identify generator components, including condensers, outlets, resistors, solenoids, and fuel shutoff valves.
	5.1.9	Explain circuit breaker types, operation, and ratings.
	5.1.10	Explain N.E.M.A. configuration of outlets.
	5.1.11	Explain, locate, and identify the various functions of switches, including actuating switches, switches classified by poles and throws, push-button switches, rotary switches, circuit breakers, thermal switches, and pressure switches.
	5.1.12	Explain the purpose and use of transfer switches.
	5.1.13	Explain effects on the generator of the start-up load of a motor on various applications.
	5.1.14	Explain to the customer the proper sizing of generators for the desired job.
Topic 5.2	**Generator Service**	
	Student Competencies	
	5.2.1	Demonstrate disassembly and assembly of generator components, including rotor windings, stator windings, rotor bearings and carriers, brushes, circuit boards, circuit breakers, transformers, idle control components, and magnetic pickups.
	5.2.2	Follow circuit diagrams.

Topic 5.3	Generator Troubleshooting	
	Student Competencies	
	5.3.1	Demonstrate the use of the following troubleshooting tools: volt/ohm meter, megohmmeter, amp clamp, frequency meter, and load bank.
	5.3.2	Explain and troubleshoot idle control systems, including idle control solenoid, idle control transformer, idle control circuit board, and stepper motor.
	5.3.3	Demonstrate the use of rotor and stator resistance tables.
	5.3.4	Test switches, including actuating switches, switches classified by poles and throws, push-button switches, rotary switches, circuit breakers, thermal switches, and pressure switches.
	5.3.5	Perform load testing of generators.
	5.3.6	Given a generator with trouble symptoms installed, solve the problem using the proper manual and tools.

Career Ready Practices

1. Act as a Responsible and Contributing Citizen and Employee

Career-ready individuals understand the obligations and responsibilities of being a member of a community and demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them, think about the near-term and long-term consequences of their actions, and seek to act in ways that contribute to the betterment of their teams, families, community, and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

2. Apply Appropriate Academic and Technical Skills

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications and make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

3. Attend to Personal Health and Financial Well-Being

Career-ready individuals understand the relationship between personal health, workplace performance, and personal well-being; they act on that understanding to regularly practice health diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.

4. Communicate Clearly, Effectively, and with Reason

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice and organization and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

5. Consider the environmental, social, and economic impacts of decisions

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organizations and the environment. They are aware of and utilize new technologies, understandings, procedures, materials and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and profitability of the organization.

6. Demonstrate creativity and innovation

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

7. Employ valid and reliable research strategies

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices, or inform strategies. They use a reliable research process to search for new information and evaluate the validity of sources when considering the use and adoption of external information or practices. They use an informed process to test new ideas, information, and practices in their workplace situation.

8. Utilize critical thinking to make sense of problems and persevere in solving them

Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur, quickly take action to address the problem, thoughtfully investigate the root cause of the problem prior to introducing solutions, and carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

9. Model integrity, ethical leadership, and effective management

Career-ready individuals consistently act in ways that align to personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the direction and actions of a team or organization, and they apply insights into human behavior to change others' actions, attitudes, and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morale, and organizational culture.

10. Plan education and career path aligned to personal goals

Career-ready individuals take personal ownership of their own educational and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience, and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the educational and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

11. Use technology to enhance productivity

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring and using new technology, being proficient with ubiquitous technology applications. They understand the inherent risks, personal and organizational, of technology applications, and they take actions to prevent or mitigate these risks.

12. Work productively in teams while using cultural/global competence

Career-ready individuals positively contribute to every team whether formal or informal. They apply an awareness of cultural differences to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.