

Chapter 12

Transportation and Energy Technology Standards

Standards in transportation and energy technology address technical systems that constitute the foundation of modern living. Collectively, Transportation and Energy Technology standards provide a model for the development of transportation and energy technology program curricula for high school programs through lifelong instructional delivery systems, including retraining programs and programs for upgrading of skills. Curriculum designed from these model standards prepares persons for employment or advanced training in a variety of industries. Programs operating on standards-based curricula provide the workforce with line mechanics, service managers, electronics specialists, diagnostic technicians, nuclear engineers, and aerospace engineers.

Transportation and Energy Technology programs in California provide students with the skills to enter the workforce in an entry-level position directly out of high school and ROC/P, at the technical level after community college, or at the professional level after receiving a bachelor's degree. This sequence begins after the Technology Core program, with a broad-based course, Introduction to Transportation and Energy. The career path sequence is then tailored to each student's goal by providing the student the opportunity to enroll in such programs as Automotive Service Excellence (ASE) Automotive, ASE Auto-Body Repair, ASE Truck and Diesel, and Federal Aviation Administration (FAA) Aircraft.

Transportation and Energy Technology education programs form a powerful and positive, integrated linkage with all other disciplines. Knowledge and skills across disciplines are enhanced and reinforced, enabling students to compete in the U.S. economy as productive citizens. These programs are provided in the context of a complete, sequential program in which students are able to plan intelligently and prepare properly for a career goal.

In the transportation and energy program, students use mathematical skills, such as estimation and problem solving, in the application of algebraic, geometric, and trigonometric formulas and functions. Students practice communications by applying reading, writing, listening, speaking, visual, and nonverbal skills. Students also learn and practice scientific principles that apply to mechanical, fluid, thermal, electronic, and electrical systems. These scientific principles include the principles of force, work, rate, resistance, energy, power, and momentum.

Transportation and Energy Technology students also use skills learned in other ITE areas, such as graphic communications, electronics, and manufacturing. Sample skills include tool design; graphic illustrations; electronic-circuit testing; welding; machining; fabricating; mechanical, hydraulic, and pneumatic operations; and transportation and energy systems applications. These interdisciplinary approaches provide students with strong foundation skills and with advanced-level skills in the career field of their choice, skills which allow students to exit the program at selected points and enter into identified occupations or advanced training.

The Transportation and Energy Technology standards cover the development of transportation and energy skills and integrated skills, from the general or exploratory to the occupational specific, providing a path in which students can develop to their greatest potential and prepare to achieve postsecondary goals. All students have the right to select a career path directly related to their particular career and personal goals and receive education and training to make their goals possible. Students are able to take the necessary prerequisite courses for their chosen paths by developing their own individualized plan. Bridges exist to help students move from one path to another as they mature and develop through their high school years.

Career–technical performance standards and model curriculum integrated performance activities for Transportation and Energy Technology are presented in this chapter. The reader should review career–technical standards concurrently with related career performance standards and academic performance standards, described fully in Chapter 2, “Industrial and Technology Education Model Curriculum Standards.”

Career–Technical Performance Standards

Transportation and Energy Core (1–22)

Standard 1: Safety Practices

Students will understand the health hazards, dual risks of tobacco smoke and other toxic chemicals, safety practices, and environmental hazards related to their work in the shop. Students will operate and use equipment in the shop safely and efficiently; develop a list of environmental hazards; and discuss ways of dealing with health and safety concerns.

Standard 2: Tools and Equipment

Students will understand how specific tools are used to perform maintenance and repair operations. Students will select and use the correct tools and pieces of equipment for diagnostic and repair procedures in the shop.

Standard 3: Measurement

Students will understand the measurement scales and systems used transportation and energy operations. Students will follow industry-approved standards when using the measuring tools and measurement systems required in diagnostic and adjustment procedures.

Standard 4: Application of Scientific Principles

Students will understand scientific principles in relation to physical and chemical functions in transportation and energy systems. Students will use scientific principles of tools to explain the functioning and malfunctioning of energy systems.

Standard 5: Environmental Principles

Students will understand the effects of energy conversion systems on the environment, with an emphasis on transportation vehicles. Students will apply industry-specific regulations regarding hazardous communications and materials in the workplace.

Standard 6: Mechanical Principles

Students will understand mechanical principles in relation to Transportation and Energy Technology. Students will use basic mechanical principles to explain and analyze the function, function possibilities, and design of vehicle and energy systems.

Standard 7: Internal and External Combustion

Students will understand the operating principles of internal and external combustion engines. Students will diagnose and analyze the performance of internal and external combustion engines.

Standard 8: Hydraulic Power and Energy

Students will understand the basic principles of hydraulic power. Students will explain the applications of hydraulic power to generate electricity, mechanical movement, and force multiplication.

Standard 9: Pneumatic Power and Energy

Students will understand the basic principles of pneumatic power. Students will explain the applications of pneumatic power to generate electricity, mechanical movement, and force multiplication.

Standard 10: Electrical Power and Energy

Students will understand the basic principles of electricity and electrical power. Students will explain how electricity is generated and used as a power source. Students will explain energy conversion (from electrical to mechanical) and chemical forms in relation to transportation vehicles.

Standard 11: Nuclear Power and Energy

Students will understand the basic principles of nuclear power. Students will describe the basic operation of a nuclear reactor and explain how atomic energy can be converted to perform work.

Standard 12: Alternative Power Sources

Students will understand and describe the potential application of alternative power sources.

Standard 13: Land Transportation Systems

Students will understand land transportation vehicles, highway networks, and railroad systems. Students will describe the differences between types of vehicles; the differences between types of roadways; and the construction of highways, streets, and railroad beds.

Standard 14: Water Transportation Systems

Students will understand the physics involved in buoyancy and the need for water vehicles of various types. Students will explain how to make a piece of steel float and the operation and control of various water transportation vehicles.

Standard 15: Aerospace Transportation Systems

Students will understand basic scientific principles in relation to aerospace transportation systems. Students will explain basic propulsion systems and roll, yaw, and pitch control systems.

Standard 16: Alternative Forms of Transportation

Students will understand the operation of pipelines, conveyors, and elevators as transportation systems. Students will explain the batching of products in pipelines.

Standard 17: Basic Electricity and Electronics

Students will understand the practical and theoretical applications of voltage, amperage, and resistance in electrical circuits and equipment. Students will use such tools as meters and schematic diagrams to diagnose, service, and repair circuitry and components in various types of electronic devices and systems.

Standard 18: Factory Manuals and Research Procedures

Students will understand how to use service manuals and diagnostic procedures. Students will use various types of information-retrieval systems properly to determine specifications, repair procedures, and service procedures.

Standard 19: Maintenance Procedures

Students will understand the need for maintenance. Students will explain the conditions under which service and maintenance are required for transportation vehicles. Students will perform and document maintenance procedures in accordance with the recommendations of the manufacturer.

Standard 20: Fault Analysis and Resolution

Students will understand fault analysis and the steps that lead to fault diagnosis. Students will inspect and analyze the cause of component failure in accordance with accepted trade practices. Students will test, replace, repair, and adjust components in accordance with factory specifications.

Standard 21: Business Practices

Students will understand the business practices of a shop. Students will generate and maintain service records in a manner consistent with current legal and industry requirements.

Standard 22: Leadership and Management

Students will understand the need for leadership and management in vocational education and work situations. Students will join such organizations as the Vocational Industrial Clubs of America (VICA) and will participate in local and state activities. Students will demonstrate such leadership and management skills as total quality management (TQM) in their class and leadership activities.

Energy Technology (23–50)**Standard 23: Computer Skills**

Students will understand the basic computer principles that apply to the use of computer hardware and software. Students will use a computer to demonstrate basic communication skills, such as word processing, graphics, and electronic mail.

Standard 24: Introduction to Documents, Records, and Forms

Students will understand the basic principles associated with the production and use of plant documents, records, and forms. Students will define document control classifications; recognize

applicable standards for design and construction, such as ASME, ANSI, and IEEE; and demonstrate the ability to prepare and retrieve documents from a document control system.

Standard 25: Plant Drawings

Students will understand the use of plant drawings. Students will identify types of plant drawings, such as piping and instrument (P&ID) drawings and electrical schematics, and demonstrate how they are used; identify and explain various symbols used in drawings; and demonstrate the use of a drawing retrieval system.

Standard 26: Maintenance Work Control

Students will understand a process used in controlling work. Students will explain the purpose of work instructions and how they are to be followed; explain the key elements of effective work instructions; and demonstrate how to write a work-request document, giving a complete and concise description of the problem, repair activities, and testing performed.

Standard 27: Parts Replacement and Equipment

Students will understand a process used in controlling parts and equipment. Students will describe a process for obtaining parts and equipment; differentiate between safety-related and nonsafety-related parts and equipment; and complete a parts request form.

Standard 28: Clearance/Tagging Program

Students will understand a process used for establishing safe work conditions. Students will describe how safe work conditions are achieved and maintained by the positioning of plant components, such as breakers, valves, and other devices; explain individual responsibilities and limitations associated with working within a tagged boundary, such as the operation of valves or components; and demonstrate a step-by-step procedure to initiate, place, and remove various types of tags and warning labels.

Standard 29: Industrial Safety Hazards

Students will understand basic industrial safe work practices. Students will describe the safe work practices to be followed while working in or near high-voltage areas, energized equipment, rotating equipment, abnormal temperatures, heavy loads, high-noise areas, and radiologically controlled areas. Students will explain the precautions to take in working with hazardous or explosive chemicals, compressed gases, or components near or over water.

Standard 30: Electrical Safety

Students will understand the fundamentals of an industrial-electrical safety program. Students will describe electrical shock symptoms and demonstrate the proper response to an electrical shock victim; define the allowable approach distance to high-voltage, energized circuits; explain the precautions to take in working with electrical lines embedded in earth, contained in structures, and positioned overhead; and identify grounding hazards and discuss ground-fault isolation procedures and precautions.

Standard 31: Chemicals, Gases, and Solvents

Students will understand the basic purpose and general requirements of a chemical-control program. Students will describe the labeling requirements for chemicals; identify hazardous chemicals and explain the precautions to take in working with those chemicals; demonstrate the proper storage of chemicals; explain the reasons for avoiding direct contact with chemicals,

including inhalation, ingestion, and absorption through the skin; and demonstrate the proper use of special protective equipment.

Standard 32: Hazardous Materials

Students will understand where to find information on hazardous materials at their worksite and how to read material-safety data sheets (MSDS). Students will locate information in the classroom on hazardous materials and read and explain an MSDS.

Standard 33: Radiation Exposure and Contamination Control

Students will understand the basic principles of a radiological and contamination protection program. Students will list and describe various sources of radiation exposure; discuss methods and techniques for minimizing exposure; and demonstrate the methods and equipment used to control the spread of contamination.

Standard 34: Working from Heights

Students will understand the basic principles for proper selection and use of equipment designed for working from heights. Students will describe the criteria for proper selection and application of the following: bucket trucks, ladders, safety belts, lines, harnesses, and scaffolding. They will explain the inspection and safety requirements that must be met prior to use of each type of safety equipment.

Standard 35: Working in Confined Spaces

Students will understand the basic principles associated with working in confined spaces. Students will describe a confined space and explain the potential hazards of working in such an area; identify tools and equipment that may be taken into a confined space; explain methods of maintaining and monitoring adequate temporary ventilation; and explain the dangers of inert gases, such as nitrogen and argon, in confined spaces, low areas, and inadequately ventilated plant areas.

Standard 36: Transportation Equipment

Students will understand the use and control of transportation equipment. Students will identify equipment designed for the transportation of material and personnel; describe the special safety precautions to take in operating each type of vehicle; demonstrate proper methods for securing vehicle loads; and identify areas having restricted vehicle access (e.g., security areas, electrical switchyards, and storage areas).

Standard 37: Measuring and Testing Equipment

Students will understand how an auditable calibration program is maintained. Students will explain the need and requirements for maintaining a calibration program; demonstrate proper use of the information on a calibration sticker or tag to determine calibration status; demonstrate proper methods for protecting measuring and testing equipment under various working conditions; and demonstrate proper procedures for using various types of measuring and testing equipment.

Standard 37: Lifting and Handling Equipment

Students will understand the operation of various types of lifting and handling equipment. Students will describe the precautions to take and signals to use in lifting components safely; identify equipment uses and limitations; and demonstrate basic rigging practices, including the proper use of attendant equipment.

Standard 38: Fasteners

Students will understand the basic principles associated with the use of mechanical fasteners. Students will identify and explain the proper use of various mechanical fasteners, including (but not limited to): bolts, nuts, screws, washers, locking devices (e.g., roll pins, snap-rings, and cotter pins), safety wire, wire terminals, and lugs; and demonstrate the proper use of tools associated with the installation and removal of various fasteners.

Standard 39: Bolting Practices

Students will understand the basic principles of good bolting practices. Students will describe the major identifying characteristics of a bolt and a screw (including SAE and metric methods of identification); identify and use torque wrenches; calculate torque specifications when using length adapters; demonstrate proper torquing patterns; identify fasteners of various hardnesses and tempers (including stretch-to-fit); and demonstrate the proper use of safety wire techniques.

Standard 40: Lubricants and Lubrication

Students will understand the fundamentals of lubricants and lubrication. Students will explain friction and the need for lubrication; explain the difference between oil, grease, and other lubricants (e.g., synthetics); identify terminology associated with the American Petroleum Index (API), such as viscosity, service rating, pour-point, and so forth; and explain the effects of heat, water, time, and other contaminants on a lubricant's effectiveness.

Standard 41: Metallurgy

Students will understand the fundamentals of metallurgy. They will explain the differences between ferrous and nonferrous metals; identify the properties of mechanical versus chemical metallurgy; explain the effects of heat, time, and corrosion on various metals; and demonstrate such processes as annealing, tempering, forging, and casting.

Standard 42: Basic Systems and Component Functions

Students will understand basic plant systems and components in relation to the production of energy. Students will identify major plant equipment; explain the purpose, application, and principles of the operation of key components in various energy-production plants; identify system flow paths; identify the interrelationship between basic systems and other plant systems and units; and identify systems affected by the plant's technical specifications.

Standard 43: Mathematics

Students will understand the basic mathematical principles associated with the production of energy. Using basic mathematical principles, students will perform calculations that include (but are not limited to) basic arithmetic functions, fractions and decimals, percentages, square roots, averages, exponential functions, number conversions, dimensional analysis, algebra, geometry, trigonometry, graphs, and control charts.

Standard 44: Physics

Students will understand the basic terms, characteristics, and concepts of various physical processes related to component and system operations and maintenance in the field of energy production. Students will describe basic mechanical principles (e.g., simple machines, such as levers, gears, cams, and pulleys), energy conversion, hydraulics, and laws of motion.

Standard 45: Electrical Science

Students will understand basic electrical science terms, units, definitions, and concepts in relation to the production of energy. They will explain fundamentals of electricity, such as electrical laws, basic electrical theories, and basic electrical circuits. Students will identify a plant's power sources, power distribution, grounding systems, electrical hazards, and safety precautions.

Standard 46: Properties of Energy-Plant Materials

Students will understand basic concepts of the properties of energy-plant materials and recognize conditions that are detrimental to energy-plant materials. Students will explain the properties of metals (e.g., structures, expansion and contraction, embrittlement, yield, and tensile strength); recognize such plant-material problems as fatigue failure, corrosion, contamination, and vibration-induced cracking; and explain such concepts as galvanic corrosion, chloride stress, caustic stress, and stress-corrosion cracking.

Standard 47: Heat Transfer and Fluid Flow

Students will understand the basic concepts associated with heat transfer and fluid flow. Students will explain basic thermodynamic concepts, such as the properties of water and steam; the relationship between pressure and temperature; the basic steam cycle; and thermal efficiency. They will define basic pump theory and principles and phenomena of fluid flow, such as properties of fluids and mechanics.

Standard 49: Chemistry

Students will understand basic chemistry terms, units, definitions, and concepts. Students will demonstrate the fundamentals of chemistry in relation to the energy industry by performing lab experiments, using mixtures, solutions, and compounds; explaining properties and analysis methods; defining corrosion chemistry; and explaining a process for the control and removal of impurities.

Standard 50: Fire Protection

Students will understand the basic fire hazards found in the energy industry. They will describe the elements of combustion; identify various types of fires and extinguishing methods; and identify the types of equipment used, describing their limitations. Students will describe safe work practices to follow in fighting a fire; identify allowable approach distances and the precautions to be taken; and demonstrate the proper application and use of fire-extinguishing equipment.

Electrical Strand (55–66)

Standard 55: Electron Theory and Magnetism

Students will understand basic electron theory and magnetism. They will explain basic atomic principles and the movement of electrons through matter; define such electrical terms as charged particles, Coulomb's law, static electricity, potential difference, and electromotive force; and demonstrate the laws of magnetism by constructing a basic electromagnet.

Standard 56: Conductors, Insulators, and Semiconductors

Students will understand that, in relation to electricity, all matter acts as a conductor, insulator, or semiconductor. They will explain the factors that affect a conductor's ability to conduct electricity; such factors would include resistivity, the length of a conductor, cross-sectional area of a

conductor, and the effects of heat on a conductor. Students will explain the basic principles associated with semiconductors, such as valence and doping, and identify the elements known to be semiconductors.

Standard 57: Meters

Students will understand the use and application of various basic electrical meters. Students will operate a digital multimeter safely to perform voltage, resistance, and current measurements.

Standard 58: Fundamentals of Electrical Circuits

Students will understand the fundamentals of basic electrical circuits. They will construct, calculate, and perform measurements on components that are arranged in series, parallel, and combination configurations. Students will use the principles of Ohm's law and Kirchhoff's law to analyze DC circuits.

Standard 59: Inductance, Capacitance, Impedance, and Resonance

Students will understand the fundamentals of basic AC circuits. Students will explain the mathematical relationship between period and frequency; identify basic components of an AC generator; calculate impedance in R-L-C series and parallel circuits; and define true power, apparent power, reactive power, and volt-amperes reactivity (VAR).

Standard 60: Theory of Plant Electrical Components

Students will understand the theory of operation of basic plant electrical components. Students will explain the basic operating principles associated with plant electrical equipment, such as motors, generators, transformers, voltage regulators, and inverters.

Standard 61: Control Circuitry

Students will understand the fundamentals of control circuitry. Students will explain various instrumentation schemes for control circuitry, ground detection, protective relaying (including the use of associated drawings for diagnosing troubles), control metering, and various types and sizes of cables.

Standard 62: Transformers

Students will understand the basic principles of the operation of transformers. Students will describe the basic types, functions, and operating principles of transformers; explain a process for troubleshooting for fault symptoms and hazards; explain the safety and environmental precautions to take in the handling of cooling mediums; and explain the basic theory of fire-protection systems.

Standard 63: Basic Electronics

Students will understand the fundamentals of basic electronics. They will describe the operation of basic electronic devices, such as diodes, transistors, and silicon-controlled rectifiers (SCRs); explain the operation of basic electronic circuits, such as power supplies, amplifiers, filters, and switching circuits.

Standard 64: Electrical-Supply Components

Students will understand the fundamentals of basic electrical-supply components. Students will describe the operation of and perform basic service procedures for switch gears, load centers, and

motor-control centers; explain the operating principles of inverters and uninterruptible power supplies; and describe the operating principles, safety precautions, and environmental concerns associated with batteries and battery chargers.

Standard 65: Electrical-Valve Actuators

Students will understand the basic principles associated with electrically operated valve actuators. They will explain the manual operation of a valve actuator; perform basic service and testing procedures; demonstrate a process for adjusting position indicators; and describe the impact of environmental conditions on the operation of electrically-operated valve actuators.

Standard 66: Structural and Auxiliary Equipment

Students will understand the fundamentals of electricity in relation to structural and auxiliary equipment. Students will perform electrical testing and service procedures associated with hoists and cranes. They will describe the significance of fire barriers in relation to electrical-cable runs and penetrations. Students will also describe an electrical service process associated with electric boilers and elevators.

Instrument and Control Strand (70–77)

Standard 70: Advanced Electronics Theory

Students will understand advanced electronic theory. They will explain the operational concepts associated with operational amplifiers (op-amps), integrated circuits, and other solid-state components and circuitry. Students will construct and troubleshoot advanced electronic circuits.

Standard 71: Digital Electronics

Students will understand the fundamentals of digital electronics. They will use the concepts of Boolean algebra to explain the fundamentals of basic digital logic circuitry; demonstrate the use of the *and*, *or*, and *not* logic elements and verify their logic functions; demonstrate the use of *and-not*, *or-not*, and *and/nand* logic elements and verify their functions; and explain the methods used in basic programming and control-circuit timing.

Standard 72: Process-Measurement Systems

Students will understand basic process-measurement systems. They will explain detection, signal conditioning, and indication and control as it relates to the basic steps required in measurement processes; draw and explain a basic block diagram of a simple instrument channel; explain the materials, equipment, measurement devices, and processes associated with pressure detection, fluid flow, level detection, and temperature detectors.

Standard 73: Fundamentals of Control

Students will understand how a control system is used to regulate a process by manipulating material to produce a desired product. Students will draw and explain the fundamentals of a manually controlled process; describe the operational concepts of the four major elements of an automatic control system; and define closed-loop control and loop tuning.

Standard 74: Signal Conditioning and Controllers

Students will understand how automatic controllers continually scan a process for variations and make adjustments in response to those variations to restore the process to its balanced, steady-

state condition. Students will identify the four basic controller types: (1) two-position controllers; (2) proportional controllers; (3) proportional-plus-reset controllers; and (4) proportional-plus-reset-plus-rate (PID) controllers. Students will perform control-loop tuning on a simulated process.

Standard 75: Fundamentals of Electronic Instrumentation

Students will understand the extensive use of specialized electronic circuits, combined with conventional power-supply and amplifier circuits, as detecting and computing devices throughout the instrument-and-control industry. Students will explain the function of each block in a block diagram of a transmitter or controller; explain how an LVDT converts linear motion to a proportional electrical signal and detects the signal's direction; explain how a force-balance transmitter acts as a motion-to-current converter; and explain how a diaphragm is used to convert a differential pressure to a proportional change in capacitance.

Standard 76: Fundamentals of Pneumatic Instrumentation

Students will understand the principles of operation and characteristics of basic pneumatic instruments and controllers. Given a drawing of a flapper/nozzle assembly, students will describe the manner in which it detects motion and produces a proportional-pressure signal; describe how a pilot-motion detector detects motion and produces a proportional pressure signal; state the two major components of a pneumatic relay; differentiate between motion balance and moment balance; and, given a drawing of a pneumatic-control system, explain its response to a change in the input.

Standard 77: Fundamentals of Chemical Instrumentation

Students will understand the principles of operation and characteristics of on-line chemistry instrumentation. Students will explain the operation of the following types of on-line chemistry instruments: conductivity analyzers, turbidity detectors, and dissolved oxygen analyzers.

Mechanical Strand (80–98)

Standard 80: Pump Fundamentals

Students will understand the principles of operation and characteristics of basic centrifugal and positive-displacement pumps. Students will disassemble, identify, clean, inspect, measure (for wear), and reassemble the parts of centrifugal and positive-displacement pumps. They will remove, inspect, measure, and replace a basic mechanical seal in a positive-displacement pump.

Standard 81: Valve Maintenance (Phase 1)

Students will understand the purpose and classification of valves and the design functions of various types of valves. Students will identify the basic types of valves and their components and demonstrate the functions of those components. Students will explain the flow characteristics of various types of valves.

Standard 82: Valve Maintenance (Phase 2)

Students will understand maintenance procedures for operational components of various types of valves. Students will disassemble a standard type of valve; remove and replace the packing; clean, inspect, and replace or restore damaged parts; and reassemble the valve. Students will identify common valve malfunctions.

Standard 83: Pipes and Pipe Fittings

Students will understand the maintenance procedures for ensuring the proper installation of a piping system, using the appropriate fittings. Students will conduct a routine inspection to detect signs of wear or damage and will perform the necessary maintenance procedures for correcting or replacing a defective fitting or a line of pipe.

Standard 84: Rolling Contact Bearings

Students will understand the operational characteristics of various types of rolling contact bearings. Students will demonstrate the removal of a failed rolling contact bearing; examine a rolling contact bearing to detect the cause of bearing failure; and demonstrate the proper procedure for installing rolling contact bearings.

Standard 85: Sliding-Surface Bearings

Students will understand the operational characteristics of various types of sliding-surface bearings. Students will identify the basic parts of a ring-oiled journal bearing and explain the operation of this type of bearing; identify the basic parts of a tilting-pad thrust bearing and explain the operation of this type of bearing; and describe the steps involved in troubleshooting a sliding surface bearing.

Standard 86: Strainers, Filters, and Traps

Students will understand the purposes and operational characteristics of various types of strainers, filters, and traps. Student will identify the parts of basic filtering system; remove and replace a set of cartridge-type filters; and demonstrate the proper procedures for cleaning a strainer in an operating system.

Standard 87: Steam Traps

Students will understand the purposes and operational characteristics of the three basic types of steam traps: thermostatic, mechanical, and thermodynamic. Students will explain the purpose of a steam trap; compare the three basic types of steam traps; and identify the parts of a typical bellows trap, explaining each part's function.

Standard 88: Steam Turbines

Students will understand the operating characteristics of a basic steam turbine. Students will identify and explain the purposes of the main components of a basic steam turbine; explain the processes used to construct a steam turbine; and identify and explain the purpose of steam-turbine accessories and support systems.

Standard 89: Heat Exchangers and Condensers

Students will understand the principles of the operation of heat exchangers and condensers. Student will identify and explain the operation of the two basic types of heat exchangers: the closed type and the open, or deaerating, type; explain the maintenance problems of the two basic types of heat exchangers; and perform minor maintenance routines for heat exchangers.

Standard 90: Compressors

Students will understand the operating characteristics of the two general types of compressors. Students will identify the major components and explain the operating principles of positive displacement and dynamic compressors; explain the cause of moisture generation inside a

compressor and list three reasons for removing the moisture; and explain how and why a compressor requires a control system which matches the compressor's output to the demands of the air system.

Standard 91: Diesel Engines

Students will understand the operating characteristics of basic large-scale stationary diesel engines. Students will identify and explain the purpose of the main structural components in a large-scale stationary diesel engine; identify and explain the purposes of the moving components; and identify and explain the purposes of the accessories and support systems of a large-scale stationary diesel engine.

Standard 92: Heating, Ventilation, and Air Conditioning (HVAC) Systems

Students will understand the basic principles and operating characteristics of a basic HVAC system. Students will identify and explain the purposes of the main components of a basic HVAC system; identify and explain the purposes of the main structural components of a basic HVAC system; and identify and explain the purposes of the accessories and support systems in such a system.

Standard 93: Basic Rigging (Phase 1)

Students will understand the rigging process of moving heavy loads with ropes, chains, hoists, and other special tools. Students will name the three elements of rigging safety; list the four basic steps of planning a rigging job; identify and explain the purposes of such rigging equipment as hoists, cranes, slings, connectors, and adjusters.

Standard 94: Basic Rigging (Phase 2)

Students will understand the application of rigging techniques to a specific job. Students will describe a technique used for estimating sling lengths; list alternative methods for leveling an unbalanced load; list the rigging equipment required and note the capacity of each component for a given load; sketch a plan of a rigging job, indicating all pertinent information; identify the standard hoisting signals; and name four safety precautions that must be followed when loads are aloft.

Standard 95: Nondestructive Testing

Students will understand the fundamentals of nondestructive testing. Students will discuss the purpose of nondestructive testing and will explain the processes used in the four basic types of nondestructive testing: magnetic-particle testing, ultrasonic testing, radiographic testing, and liquid-penetrant testing. Students will list the advantages and disadvantages of the four basic types of nondestructive testing.

Standard 96: Couplings and Shaft Alignment

Students will understand the fundamentals of shaft couplings and shaft alignment. Students will define the purpose of couplings; identify different types of couplings; disassemble, clean, inspect, and reassemble a grid-type coupling; identify four major types of misalignment; list the steps involved in measuring for misalignment; and demonstrate the method for mounting dial indicators in position for measuring misalignment.

Standard 97: Gas-Welding Equipment and Processes

Students will understand the basic equipment and principles of oxyacetylene welding. Students will identify the safety rules for oxyacetylene welding; identify and explain the operation of all of the components of a basic oxyacetylene-welding unit; set up the unit in preparation for proper operation; ignite and adjust the flame on a oxyacetylene torch; and perform basic welding processes, such as brazing and fusion welding.

Standard 98: Electric-Arc Welding

Students will understand the basic equipment and principles of electric-arc welding. Students will identify the safety rules for electric-arc welding; identify and explain the operation of all of the components of a basic AC and DC electric arc-welding unit; set up the units in preparation for proper operation; perform basic welding processes on materials that vary in type and thickness; and produce basic types of arc-welding joints, including butt, lap, and fillet.

Operations Strand (100–113, with 55, 56, 72, 73, 81, 87, and 89 repeated)

Standard 100: Integrated Plant Operations

Students will understand the theory of operation of basic industrial plants, including electrical generating stations, refineries, and other plants that rely on large-scale conversion of energy. Students will explain the basic principles of the major processes used by these plants.

Standard 101: Plant Monitoring Tours

Students will understand the concept of “walking down” plant systems to verify equipment alignment per plant drawings. Students will explain and demonstrate good operating practices involved in performing a thorough plant tour (logkeeping, equipment monitoring, and so forth).

Standard 102: Theory of Steam Generation

Students will understand the theory of operation of various boiler types. Students will identify construction characteristics and explain the similarities and differences between biomass, coal, oil, gas, geothermal, nuclear, and solar-heated boilers.

Standard 103: Boiler Operations

Students will understand the operating characteristics of the basic types of boilers. Students will identify and explain the purposes of the main components of the basic types of boilers. Students will describe the fluid and gas side-flow paths; explain the processes of thermodynamics occurring at each conversion point; and identify the methods and describe the processes used to control water chemistry. Students will describe protective features and explain the basic procedures for start-up, shutdown, and typical boiler operations.

Standard 104: Boiler Maintenance

Students will understand the maintenance procedures for basic types of boilers. Students will identify structural-support components and describe their functions; and explain the repair procedures for boiler-tube leaks and fuel leaks.

Standard 55: Theory of Plant Electrical Components

Students will understand the theory of operation of basic plant electrical components. Students will explain basic operating principles associated with plant electrical equipment, such as motors, generators, transformers, voltage regulators and inverters.

Standard 56: Control Circuitry

Students will understand the fundamentals of control circuitry. Students will explain various instrumentation schemes for control circuitry, ground detection, protective relaying (including the use of associated drawings for diagnosing troubles), control metering, and various types and sizes of cables.

Standard 105: Transformers

Students will understand the basic principles of the operation of transformers. Students will describe the basic types, functions, and operating principles of transformers; describe fault symptoms and hazards; explain safety and environmental precautions to take in handling cooling mediums; and explain the basic theory of fire protection systems. Students will describe protective features typically used on transformers (e.g., alarms and trips responding to sudden pressure, high differential, and ground fault).

Standard 106: Electrical-Supply Components

Students will understand the fundamentals of basic electrical-supply components. Students will describe the operation of and perform basic service procedures for switch-gears, load centers, and motor-control centers; explain the operating principles of inverters and uninterruptible power supplies; and describe the operating principles and safety precautions (including environmental concerns) associated with batteries and battery chargers. Students will describe protective features typically used on electrical-supply components (e.g., alarms and trips responding to over-current, under-voltage, abnormal-frequency, and high-temperature conditions).

Standard 107: Power-Operated Valve Actuators

Students will understand the basic operating principles of pneumatic and electrically operated valve actuators. Students will explain the manual operation of a valve actuator; perform basic operational testing procedures; demonstrate a process for verifying the accuracy of position indicators; and describe the impact of environmental conditions on the operation of electrically operated valve actuators.

Standard 72: Process-Measurement Systems

Students will understand basic process-measurement systems. Students will explain detection, signal conditioning, and indication and control in relation to the basic steps required in a measurement process; draw and explain a basic block diagram of a simple instrument channel; and explain the materials, equipment, measurement devices, and processes associated with pressure detection, fluid flow, level detection, and temperature detectors.

Standard 73: Control Fundamentals

Students will understand the manner in which a control system regulates a process by manipulating material to produce a desired product. Students will draw and explain the fundamentals of a manually controlled process; describe the operational concepts of the four major elements of an automatic control system; and define the processes of closed-loop control and loop tuning.

Standard 108: Pump Fundamentals

Students will understand the principles of operation and characteristics of basic centrifugal and positive-displacement pumps. Students will identify the parts of those pumps and explain the similarities and differences between them and between their operating procedures. Given a piping drawing for a selected pumping system, students will locate and describe the pump or pumps depicted in the drawing. Students will describe the protective features typically used on pumps (e.g., alarms and trips responding to low lube-oil pressure, loss of suction pressure, and high bearing temperature).

Standard 81: Valve Maintenance (Phase 1)

Students will understand the purpose and classification of valves and the design function of various types of valves. Students will identify the basic types of valves and their components and demonstrate the functions of those components. Students will explain the flow characteristics of various types of valves.

Standard 109: Strainers, Filters, and Traps

Students will understand the purposes and operational characteristics of various types of strainers, filters, and traps. Student will identify the parts of a basic filtering system; remove and replace a set of cartridge-type filters; and demonstrate the proper procedure for cleaning a strainer in an operating system. Students will describe the protective features typically used on strainers and filters (e.g., alarms responding to high-differential pressure and low-discharge pressure).

Standard 87: Steam Traps

Students will understand the purposes and operational characteristics of the three basic types of steam traps: thermostatic, mechanical, and thermodynamic. Students will explain the purpose of a steam trap; compare the three basic types of steam traps; and identify the parts of a typical bellows trap, explaining each part's function.

Standard 110: Steam Turbines

Students will understand the operating characteristics of a basic steam turbine. Students will identify and explain the purposes of the main components of a basic steam turbine; explain the processes used to convert the internal energy of expanding steam to the mechanical energy of the turbine rotor; and identify and explain the purpose of the steam-turbine accessories and support systems. Students will describe protective features typically used on steam turbines (e.g., trips responding to low lube-oil pressure, high vibration, thrust-bearing wear, and loss of condenser vacuum).

Standard 89: Heat Exchangers and Condensers

Students will understand the principles of the operation of heat exchangers and condensers. Student will identify and explain the operation of the two basic types of heat exchangers: the closed type and the open, or deaerating, type. Students will explain the maintenance problems of and perform minor maintenance routines for the two basic types of heat exchangers.

Standard 111: Gas Compressors

Students will understand the operating characteristics of the two general types of gas compressors: positive-displacement and dynamic. Students will identify the major components and explain the operating principles of those compressors; explain the causes of moisture condensation inside a compressor, its associated piping, and accumulator tanks and list three reasons for

removing the moisture; and explain how and why an air compressor requires a control system to match the compressor's output to the demands of the air system. Students will describe protective features typically used on air compressors (e.g., alarms and trips responding to low lube-oil pressure, high-discharge pressure, and over-current).

Standard 112: Diesel Engines

Students will understand the operating characteristics of basic large-scale stationary diesel engines. Students will identify and explain the purpose of the main structural components in a large-scale stationary diesel engine; identify and explain the purposes of the moving components; identify and explain the purposes of the accessories and support systems of large-scale stationary diesel engines. Students will describe protective features typically used on diesel engines (e.g., alarms and trips responding to low lube-oil pressure, over-speed, and high temperatures).

Standard 113: Heating, Ventilation, and Air Conditioning (HVAC) Systems

Students will understand the basic principles and operating characteristics of a basic HVAC system. Students will identify and explain the purposes of the main components of a basic HVAC system; identify and explain the purposes of the main structural components of a basic HVAC system; and identify and explain the purposes of the accessories and support systems in such a system. Students will describe protective features typically used on refrigeration compressors (e.g., alarms and trips responding to low lube-oil pressure, over-current, and high temperatures).

Professional-Engineering Strand (120–131)

Standards 120–131 are still under development.

Standard 120: Engineering Economics

Students will understand the principles of supply and demand, microeconomics, macroeconomics, and optimization of engineering solutions.

Standard 121: Thermodynamics

Students will understand the laws of thermodynamics.

Standard 122: Fluid Statics and Dynamics

Students will understand Reynolds numbers, forced convection, and the difference between turbulence and laminar flow.

Standard 123: Electricity and Electronics

Students will understand the analysis of AC and DC circuits.

Standard 124: Chemistry

Students will understand oxidation-reduction reactions.

Standard 125: Nucleonics

Students will understand basic nuclear reactions and fission-chain reactions.

Standard 126: Mechanics of Materials

Students will understand strength, alloys, and testing.

Standard 127: Power Cycles

Students will understand the Brayton and Rankin cycles.

Standard 128: Statics

Students will understand the theory of stability.

Standard 129: Dynamics

Students will understand kinematics and kinetics.

Standard 130: Systems Analysis

Students will understand feedback, stability, oscillation, Nyquist diagrams, bode plots, the analysis of Laplace transformation, and the linear-differential equation modeling of systems.

Standard 131: Essential Mathematics

Students will understand algebra and trigonometry, differential and integral calculus, Bessel functions, and probability and statistics.

Chemical Strand (140–144, with 78 repeated)

Standard 140: Water Treatment Fundamentals

Students will understand basic water chemistry and water treatment. Students will explain the basic principles associated with major water treatment processes (filtration, ion exchange, and dilution).

Standard 78: Chemical Instrumentation Fundamentals

Students will understand the principles of operation and characteristics of on-line chemistry instrumentation. Students will explain the operation of the following types of on-line chemistry instruments: conductivity analyzers, turbidity detectors, and dissolved-oxygen analyzers.

Standard 141: Pump Fundamentals

Students will understand the principles of operation and characteristics of basic centrifugal and positive-displacement pumps, including chemical-metering pumps. Students will disassemble, identify the parts, clean, inspect, and reassemble small centrifugal and positive-displacement pumps. Students will explain the applications and operation of laboratory pumps (peristaltic, vacuum, and so forth).

Standard 142: Valve Fundamentals

Students will understand the purposes and classification of valves and the design functions of various types of valves. Students will identify each of the basic types of valves and their components; demonstrate the functions of the working components of basic types of valves; and explain the flow characteristics of the different types of valves.

Standard 143: Fundamentals of Piping, Tubing, and Fittings

Students will understand the methods for ensuring that a chemical piping or tubing system is properly installed with the appropriate fittings. Students will detect signs of wear or damage

during a routine inspection and explain the safety precautions to take in correcting or replacing a defective line of pipe or a fitting.

Standard 144: Sewage Treatment

Students will understand the basic principles of sewage treatment. They will describe the basic operations of primary treatment, including the collection of influent wastewater, filtration, sedimentation, skimming, and sludge digestion. Students will then describe the basic operations of secondary treatment, including the operation of biological reactors and clarification.

Transportation Technology

General Automotive Technology (230–244)

Standard 230: Engines

Students will understand the functions and interrelationships of gasoline engine parts and components. Students will repair, service, adjust, and replace engine parts and components in accordance with the manufacturer's specifications.

Standard 231: Fuel Systems

Students will understand the functions of the basic components of carburetors and injection-type fuel systems. Students will demonstrate and explain the operations of various fuel systems; and they will demonstrate and explain the service procedures for those systems in accordance with the manufacturer's specifications.

Standard 232: Electrical Systems

Students will understand the design purposes and functions of automotive electrical and ignition systems and explain their interrelated operations. Students will demonstrate and explain the basic industry-required service procedures for each automotive electrical system.

Standard 233: Automotive Tuneup

Students will understand the need for automotive engine tuneup. Students will diagnose malfunctions, replace, and adjust components and service systems related to basic vehicle tuneup.

Standard 234: Emission Controls

Students will understand the environmental impact of the automobile and on-board vehicle systems designed to deal each area of concern. Students will use HC/CO/CO₂ diagnostic equipment to explain and test the functions of vehicle emission-control systems.

Standard 235: Automotive Air Conditioning

Students will know the basic principles of the air-conditioning refrigeration cycle and the basic components of the system. Students will demonstrate and explain basic air-conditioning service procedures, including the recycling of CFCs.

Standard 236: Drivetrain

Students will know the basic parts of the drivetrain and understand their functions. Students will identify and describe the failures and malfunctions that can occur in the drivetrain system.

Standard 237: Tires and Wheels

Students will understand the construction and classification of tires and wheels and the physical forces that affect their functions. Students will identify wear and failure characteristics on tires and describe industry-recommended service and repair procedures.

Standard 238: Brakes

Students will understand the basic and antilock braking-system components, parts, and functions. Students will understand the physical principles used in the operation of mechanical and hydraulic brakes. Students will explain brake-system deterioration, wear, and failure and the service procedures required by those conditions.

Standard 239: Steering and Suspension

Students will understand the operations of steering and suspension systems. Students will understand the geometrical principles applied to steering and suspension systems. Students will identify the basic parts of the steering and suspension system and explain their operation.

Standard 240: Electric-Car Controllers

Students will understand AC and DC controllers and their operating frequencies. Students will explain the operation, analysis, and service repair of controllers and make adjustments as needed.

Standard 241: Electric-Car Battery Systems

Students will understand the various types of batteries and battery systems. Students will diagnose, service, repair, and install various battery systems.

Standard 242: Electric-Car Motors

Students will understand the construction and operation of AC and DC motors. Students will diagnose, service, repair, and adjust motor systems as needed.

Standard 243: Electric-Car Accessory Systems

Students will understand how accessory systems are driven, their purposes, and their operation. Students will diagnose, service, repair, and adjust accessory systems as needed.

Standard 244: Restraint Systems

Students will understand the relationship of glass and structural crushing to the proper deployment of air bags. They will understand operation and repair procedures for active, passive, and supplemental air-bag restraint systems. Students will inspect, remove, and replace active and passive restraints; deploy supplemental restraints; and verify the proper operation of restraint systems in accordance with the manufacturer's specifications.

Air-Cooled Gasoline Engine (250–259)**Standard 250: Principles of Operation and Construction**

Students will understand the basic operating principles of two-stroke-cycle and four-stroke-cycle gasoline engines. Students will explain the functions of the various engine parts during each stroke and describe how each part is interrelated in the output of energy.

Standard 251: Engine Block and Internal Components

Students will understand how each part of the engine-block assembly operates and interacts with other parts to perform work functions in a running engine. Students will explain how the design and fit of each part is related to a specific function or functions of the engine.

Standard 252: Valves and Seats

Students will understand the design and construction of valves and their relationship to seat design and guide design. Students will service valves, springs, seats, and guides to bring them up to factory specifications.

Standard 253: Ignition Systems

Students will understand the operation of point-ignition systems and solid-state ignition systems. Students will diagnose common system failures and perform necessary service and repair procedures in accordance with the manufacturer's specifications.

Standard 254: Fuel System

Students will understand the function of the fuel system in an air-cooled gasoline engine. Students will diagnose the malfunctioning of, rebuild, and service fuel systems in air-cooled engines.

Standard 255: Governor Controls

Students will understand the basic theory and application of governor controls. Students will diagnose governor malfunctions and will service and adjust pneumatic and mechanical governors of air-cooled gasoline engines.

Standard 256: Cooling Systems

Students will understand the design and functions of air-cooling systems. Students will troubleshoot and service cooling systems in air-cooled engines.

Standard 257: Lubrication Systems

Students will understand the design of lubrication systems in relation to the physical properties of oil. Students will diagnose failures in lubrication systems and perform the necessary service and repairs in accordance with factory specifications.

Standard 258: Exhaust Systems

Students will understand the function and design of the exhaust system in air-cooled gasoline engines. Students will diagnose the malfunctioning of and service, adjust, and repair exhaust systems in accordance with factory specifications.

Standard 259: Starter Systems

Students will understand starter electromechanical concepts design application. Students will troubleshoot, service, and repair the manual and electric starters used in various engine designs.

ASE Certification Standards

ASE Certification: Engine Repair (300–306)

Standard 300: Removal and Reinstallation of Engines

Students will understand how to remove engines and replace them in front- and rear-wheel-drive vehicles. Students will remove and install front- and rear-wheel-drive engines in accordance with industry standards.

Standard 301: General Diagnosis of Engines

Students will understand how to diagnose automotive engines. Students will interpret complaints and inspect and test engines to determine needed repairs.

Standard 302: Diagnosis and Repair of Cylinder Heads

Students will understand the diagnosis of cylinder heads and procedures for their repair. Students will remove, inspect, test, and measure the surfaces of cylinder heads to make a diagnosis and perform repairs in accordance with the manufacturer's specifications.

Standard 303: Diagnosis and Repair of Valve Trains

Students will understand how to diagnose and repair valve-train assemblies. Students will inspect, test, and measure components to recommend and perform needed repairs in accordance with industry standards.

Standard 304: Diagnosis and Repair of Engine Blocks

Students will understand how to diagnose and repair engine blocks. Students will inspect, measure, and diagnose component failures in engine blocks and perform needed repairs in accordance with the manufacturer's specifications and industry standards.

Standard 305: Diagnosis and Repair of Lubrication Systems

Students will understand how to diagnose and repair lubrication systems. Students will test, inspect, measure, and diagnose lubrication systems and perform needed repairs on lubrication components in accordance with industry standards.

Standard 306: Diagnosis and Repair of Cooling Systems

Students will understand how to diagnose and repair cooling systems. Students will inspect, test, and diagnose cooling systems and perform needed repairs in accordance with industry standards. Students will handle used coolant properly as a hazardous material and recycle or transport used coolant in accordance with current guidelines.

ASE Certification: Engine Performance (310–314)

Standard 310: General Engine Diagnosis of Performance

Students will understand how to evaluate the mechanical operation of engines. Students will inspect, test, diagnose, replace or repair, and adjust an engine's mechanical components in accordance with the manufacturer's specifications.

Standard 311: Diagnosis and Repair of Ignition Systems

Students will understand how to diagnose and repair automotive point-ignition and electronic-ignition systems. Students will inspect, test, diagnose, and repair or replace ignition-system components and adjust them to manufacturer's specifications.

Standard 312: Diagnosis and Repair of Fuel Systems

Students will understand how to diagnose and repair automotive fuel systems. Students will inspect, clean, test, diagnose, adjust, repair, and replace fuel-system components in accordance with the manufacturer's specifications.

Standard 313: Diagnosis and Repair of Emissions-Control Systems

Students will understand how to diagnose and repair automotive emissions-control systems. Students will inspect, test, diagnose, adjust, repair, and replace system components in accordance with the recommendations of the manufacturer and the regulations of the Bureau of Automotive Repair.

Standard 314: Diagnosis and Repair of Computer-Control Systems

Students will understand how to diagnose and repair the automotive computer-control systems of domestic and foreign vehicles. Students will inspect, test, diagnose, adjust or repair, and replace system components in accordance with the recommendations of the manufacturer and the regulations of the Bureau of Automotive Repair.

ASE Certification: Brakes (320-328)

Standard 320: Hydraulic Systems

Students will understand the scientific principles and component operation of automotive hydraulic-brake systems. Students will inspect, check, troubleshoot, and repair automotive hydraulic-brake systems.

Standard 321: Automotive Drum Brakes

Students will understand the scientific principles and component operation of automotive drum brakes. Students will diagnose, check, service, and repair automotive drum brakes in accordance with government and industry standards.

Standard 322: Automotive Disc Brakes

Students will understand the scientific principles and component operation of automotive disc-brake systems. Students will diagnose, check, service, and repair disc-brake systems in accordance with government and industry standards.

Standard 323: Automotive Brake/Power-Assist Units

Students will understand the hydraulic and mechanical principles of automotive brake/power-assist units. Students will diagnose, check, service, and repair automotive brake/power-assist units.

Standard 324: Parking-Brake Systems

Students will understand the operation of automotive parking-brake systems. Students will diagnose, inspect, check, repair, and adjust automotive parking brakes in accordance with government and industry standards.

Standard 325: Brake/Stop-Light Systems

Students will understand the operation of automotive brake/stop-light systems. Students will diagnose, inspect, and repair defects in a stop-light circuit in accordance with government standards and the manufacturer's requirements.

Standard 326: Hubs and Wheel Bearings

Students will understand the physical principles of an automotive hub-and-wheel-bearing system and its components. Students will inspect, diagnose, service, and replace defective hubs and wheel bearings.

Standard 327: Antilock-Brake Systems

Students will understand the operating principles of antilock-brake systems and components. Students will inspect, diagnose, and service antilock-brake systems in accordance with the manufacturer's specifications.

Standard 328: Alternate-Brake Systems

Students will understand the operating principles of alternate-brake (air and electric) systems. Students will inspect, diagnose, and service alternate-brake systems in accordance with the manufacturer's specifications.

ASE Certification: Front End (330–341)

Standard 330: Steering Columns

Students will understand the operation, diagnosis, and repair of steering columns. Students will inspect, check, and repair standard, tilt, and air bag-equipped steering columns in accordance with the manufacturer's specifications.

Standard 331: Manual-Steering Gears (non-rack-and-pinion)

Students will understand the operation of manual-steering gears. Students will inspect, check, and repair manual-steering gears in accordance with the manufacturer's specifications.

Standard 332: Power-Steering Gears (non-rack-and-pinion)

Students will understand the operation of power-steering gears and the differences between the various types of power-steering gears. Students will inspect, check, and repair power-steering gears in accordance with the manufacturer's specifications.

Standard 333: Manual Rack-and-Pinion Steering Systems

Students will understand the operation of manual rack-and-pinion steering gears. Students will inspect, check, and repair manual rack-and-pinion steering gears in accordance with the manufacturer's specifications.

Standard 334: Power Rack-and-Pinion Steering Gears

Students will understand the operation of power rack-and-pinion steering gears. Students will inspect, check, and repair power rack-and-pinion gears in accordance with the manufacturer's specifications.

Standard 335: Power-Steering Pumps

Students will understand the operation of power-steering pumps. Students will inspect, check, and repair power-steering pumps in accordance with the manufacturer's directions and specifications.

Standard 336: Steering Linkage

Students will understand the geometry and function of steering-linkage systems. Students will inspect, check, and repair steering-linkage systems in accordance with factory specifications.

Standard 337: Short-Arm/Long-Arm Front-Suspension Systems

Students will understand the functions of short-arm/long-arm steering systems. Students will inspect, check, and repair a short-arm/long-arm front-suspension system in accordance with factory specifications.

Standard 338: MacPherson Strut Front-Suspension Systems

Students will understand how MacPherson strut front-suspension systems function. Students will inspect, check, and repair a MacPherson strut front-suspension system.

Standard 339: Rear-Suspension Systems

Students will understand the functions of independent and nonindependent rear-suspension systems supported by leaf, coil, and MacPherson strut springs. Students will inspect, check, and repair rear-suspension systems in accordance with the manufacturer's specifications.

Standard 340: Wheel Alignment

Students will understand the angles of two-wheel and four-wheel alignment and their application to the automotive suspension and steering systems. Students will inspect, check, repair, and align automotive suspension and steering systems in accordance with the manufacturer's specifications.

Standard 341: Wheels and Tires Regulations

Students will understand the construction, fit, and Department of Transportation standards and ratings of tires and wheels. Students will inspect, check, and repair serviceable tires in accordance with government and industry standards. Students will inspect and check wheels for defects and replace wheels that do not meet government and industry standards.

ASE Certification: Manual Drivetrain and Axles (350–354)

Standard 350: Drive Shaft and Universal Joints

Students will understand the theory and practice of diagnosing noise and vibration in front- and rear-wheel drive shafts and universal/constant-velocity joints and determine appropriate repairs. Students will inspect, check, and service or repair rear-wheel drive shafts and front- and rear-wheel drive half-shafts in accordance with the manufacturer's specifications.

Standard 351: Diagnosis of Ring-and-Pinion Gears and Differential Case

Students will understand the theory and practice of diagnosing a conventional differential unit. Students will check, service, repair, and set up a conventional differential unit in accordance with the manufacturer's specifications.

Standard 352: Limited-Slip Differentials

Students will understand the operation of limited-slip differentials. Students will inspect, check, service, and repair a limited-slip differential in accordance with the manufacturer's specifications and taking into account noise, slip, and chatter.

Standard 353: Axle Shafts

Students will understand the causes of axle noises, vibration, and seal leakage on rear-axle units. Students will inspect, check, service, and repair a rear-axle unit.

Standard 354: Four-Wheel Drive

Students will understand the operating principles of a four-wheel-drive transfer case. Students will diagnose, check, service, and repair four-wheel-drive components, including the transfer case and propeller shafts, in accordance with the manufacturer's specifications.

ASE Certification: Automatic Transmission and Transaxle (360–363)

Standard 360: Diagnoses

Students will understand diagnostic procedures for fluids, pressures, stall, torque converters, electrical/electronic components, and vacuum. Students will diagnose various transmission problems.

Standard 361: Maintenance and Adjustment

Students will understand maintenance and adjustment procedures for automatic transmissions and transaxles. Students will perform periodic maintenance and adjustments on linkages and cables, bands, fluid levels, and electronic-control circuits in accordance with the vehicle manufacturer's specifications.

Standard 362: In-Vehicle Service

Students will understand in-vehicle service techniques. Students will service seals, gaskets, governors, the valve body, and electronic components in accordance with the vehicle manufacturer's specifications.

Standard 363: Off-Vehicle Repair and Service

Students will understand the procedures for off-vehicle service and repair. Students will adjust, service, repair, or overhaul transmissions out of the vehicle in accordance with the vehicle manufacturer's specifications.

ASE Certification: Electricity and Electronics (370–379)

Standard 370: General Diagnosis of Electrical Systems

Students will understand how to diagnose and repair automotive electrical systems. Students will check, test, diagnose, repair, and adjust automotive electrical systems and components.

Standard 371: Diagnosis and Service of Batteries

Students will understand battery operation, testing, and servicing procedures. Students will inspect, test, clean, charge, and replace batteries and battery-circuit components in accordance with the manufacturer's recommendations.

Standard 372: Diagnosis and Repair of Starting Systems

Students will understand the operation of, testing of, and repair procedures for starting systems. Students will remove, inspect, test, and repair or replace starting-system components in accordance with industry standards.

Standard 373: Diagnosis and Repair of Charging Systems

Students will understand the operation of, testing of, and repair procedures for charging systems. Students will remove, inspect, test, and repair or replace charging-system components in accordance with industry standards.

Standard 374: Diagnosis and Repair of Lighting Systems

Students will understand the operation, diagnosis, and repair of automotive lighting systems. Students will inspect, test, aim, and repair or replace wires, connectors, bulbs, sockets, and switches in accordance with industry standards.

Standard 375: Diagnosis and Repair of Driver-Information Systems

Students will understand the operation of and diagnostic procedures for meters, gauges, warning lamps and devices, relays, and related electrical circuits. Students will remove, inspect, test, repair, and replace system components, using industry-accepted procedures.

Standard 376: Diagnosis and Repair of Horns, Wipers, and Washers

Students will understand horn and windshield-wiper circuits, diagnostic techniques, and component-testing procedures. Students will trace circuits and inspect, test, repair, and replace components, using industry-accepted procedures.

Standard 377: Diagnosis and Repair of Accessory Circuits

Students will understand the operation of, testing techniques for, and repair procedures for automotive electrical-accessory circuits. Students will trace circuits and inspect, test, and repair or replace components, using industry-accepted procedures.

Standard 378: Diagnosis and Repair of Body-Electronics Systems

Students will understand the operation of, diagnosis of, and testing procedures for computer-controlled body-electronics systems. Students will trace circuits and inspect, test, and repair or replace components, using procedures recommended by the manufacturer.

Standard 379: Diagnosis and Repair of Engine-Management Systems

Students will understand computer-controlled engine-management systems and the procedures for their diagnosis and testing. Students will trace circuits and inspect, test, and repair or replace components, using procedures recommended by the manufacturer.

ASE Certification: Heating and Air Conditioning (380-383)

Standard 380: Refrigeration Cycle

Students will understand the refrigeration cycle and its application in automotive air-conditioning systems. Students will inspect, check, diagnose, service, and repair an automotive air-conditioning system in accordance with industry standards.

Standard 381: System Controls

Students will understand the operation of electrical and vacuum/mechanical controls in heating and air-conditioning systems. Students will diagnose, inspect, check, service, and repair electrical and vacuum/mechanical heating and air-conditioning controls.

Standard 382: Automatic and Semiautomatic Controls

Students will understand the operation of and test procedures for diagnosing automatic and semiautomatic heating and air-conditioning controls. Students will diagnose, check, and repair automatic and semiautomatic air-conditioning and heating controls.

Standard 383: Chlorofluorocarbons (CFCs)

Students will understand the chemical reaction of CFCs with the atmosphere and the necessity of recycling Freon. Students will recycle Freon from air conditioning systems in accordance with the manufacturer's specifications and will become CFC certified.

Standard 384: Refrigerant Recycling

(Standard to be developed.)

ASE Certification: Automotive Machinist (390 series)

(New ASE certification area under development.)

ASE Certification: Electronic Diagnostic Technician (400 series)

(New ASE certification areas under development.)

ASE Certification: Automotive-Body Repair (500-511)

Standard 500: Nonstructural Analysis and Damage-Repair Preparation

Students will understand damage reporting and nonstructural analysis. Students will demonstrate how to prepare damage reports, properly identify vehicles, properly sequence inspections, use collision-estimating manuals, and complete damage reports in accordance with industry standards.

Standard 501: Outer-Body Panel Repairs

Students will understand techniques used in outer-body panel repairs, replacements, and adjustments. Students will remove, repair, and replace steel and aluminum body panels, doors, deck lids, and hoods and make adjustments and alignments in accordance with the manufacturer's specifications.

Standard 502: Metal Finishing and Filling

Students will understand the techniques of metal finishing and filling. Students will grind, sand, and restore contours with heat and plastic body fillers in accordance with industry standards.

Standard 503: Moveable Glass and Hardware

Students will understand diagnostic and repair procedures for moveable glass and hardware. Students will inspect, adjust, and repair or replace all power accessories, window glass, and hardware in accordance with industry standards. Students will explain the importance of glass to the structural integrity of a vehicle.

Standard 504: GMAW (MIG) Welding

Students will understand welding procedures, protection of sensitive components, and weld selection. Students will identify weldable materials; select the correct wire size, amperage, and weld type; and perform the required welds in accordance with industry standards.

Standard 505: Structural Analysis and Frame Inspection and Repair

Students will understand structural analysis, frame inspection, and repair procedures as required by I-CAR. Students will straighten and align frames and cross-members in accordance with the specifications of I-CAR and the manufacturer.

Standard 506: Unibody Inspection, Measurement, and Repair

Students will understand inspection, measurement, and repair procedures for unibody construction as required by I-CAR. Students will measure damaged vehicles and compare the measurements to specifications, repair damaged components, and align openings in accordance with the specifications of I-CAR and the manufacturer.

Standard 507: Mechanical and Electrical Components

Students will understand automotive mechanical and electrical operation, diagnosis, and repair procedures. Students will inspect, adjust, repair, and replace mechanical and electrical components in accordance with industry standards.

Standard 508: Restraint Systems

Students will understand the relationship of glass and structural crushing to proper air bag deployment and the operation and repair procedures for active, passive, and supplemental air-bag restraint systems. Students will inspect, remove, and replace active and passive restraints, deploy supplemental restraints, and verify systems operations in accordance with the manufacturer's specifications.

Standard 509: Preparation of Surfaces for Painting and Refinishing

Students will understand paint-removal techniques. Students will remove paint chemically and mechanically and prepare surfaces for refinishing in accordance with the manufacturer's specifications.

Standard 510: Paint Mixing and the Operation of Paint Guns

Students will understand paint matching, paint mixing, and paint-gun operations. Students will color-match, mix, reduce, and apply paint, using the proper air pressure and spray pattern.

Standard 511: Paint Application and Finish Defects

Students will understand the cause-and-effect relationship between paint and surface blemishes. Students will inspect and identify paint application problems and will repair or repaint in accordance with I-CAR and industry standards.

Truck and Diesel (600-611)

Standard 600: Two-Stroke-Cycle and Four-Stroke-Cycle Diesel Engines

Students will understand the operating principles of two- and four-stroke-cycle diesel engines. Students will identify the strokes of two- and four-stroke-cycle diesel engine operation and will evaluate engine performance.

Standard 601: Engine Disassembly

Students will understand the sequence of diesel-engine disassembly and the inspection procedures for each component. Students will disassemble a diesel engine; inspect the engine for wear; and complete a work order, indicating the cost of replacement parts and repairs needed to restore the engine to factory specifications.

Standard 602: Engine Assembly

Students will understand the proper procedure for reassembling an engine. Students will assemble the engine, adhering to proper clearances, fastener torques, and other factory specifications.

Standard 603: Engine Electrical Systems

The student will understand the electromechanical principles applied to heavy-duty starting, charging, and accessory circuits. Students will inspect, check, troubleshoot, and repair heavy-duty electrical systems in accordance with the manufacturer's specifications.

Standard 604: Truck, Tractor, and Trailer Electrical Systems

Students will understand the wiring circuits and components used on trucks, tractors, and trailers. Students will inspect, check, troubleshoot, and repair truck, tractor, and trailer electrical circuits in accordance with industry and Interstate Commerce Commission standards.

Standard 605: Hydraulic Devices

The students will understand the hydraulic principles applied in the hydraulic-system components of trucks, tractors, and trailers. Students will inspect, check, troubleshoot, service, and repair hydraulic-system components in accordance with industry and Interstate Commerce Commission standards.

Standard 606: Pneumatic Devices

Students will understand the physical principles applied in the pneumatic devices used in trucks, tractors, and trailers. Students will inspect, check, service, troubleshoot, and repair pneumatic systems and components in accordance with industry, government, and manufacturers' standards.

Standard 607: Wheels and Tires

Students will understand the construction, fit, applications, and Department of Transportation standards and ratings of heavy-duty tires and wheels. Checking for defects, students will inspect wheels and tires and replace or repair them in accordance with industry and government standards.

Standard 608: Heavy-Duty Suspension and Steering Systems

Students will understand the geometric and physical principles applied in the components of heavy-duty suspension and steering systems. Students will inspect, check, service, troubleshoot, repair, and align heavy-duty suspension and steering systems in accordance with government and industry specifications.

Standard 609: Heavy-Duty Transmission Systems

Students will understand the physical principles applied in heavy-duty transmissions. Students will inspect, check, service, troubleshoot, and repair heavy-duty transmissions systems in accordance with the manufacturer's specifications.

Standard 610: Heavy-Duty Drive Lines and Drive Axles

Students will understand how to inspect, service, and repair heavy-duty drive lines and drive axles. Students will inspect, check, service, troubleshoot, and repair heavy-duty drive-line assemblies and drive-axle units in accordance with the manufacturer's specifications.

Standard 611: Refrigeration Systems

Students will understand principles of refrigeration and the components used in cab and refrigerated-trailer systems. Students will inspect, check, service, troubleshoot, and repair a cab and a refrigerated-trailer system in accordance with industry and environmental standards.

FAA Aircraft General Technology

Special Notes Regarding Aircraft

The standards for aircraft airframe and power-plant mechanics must meet the requirements of the *Federal Aviation Administration (FAA)*, Part 147, Appendixes A, B, C, and D.

Persons attempting certification as an airframe mechanic or power-plant mechanic must take the general-curriculum subjects in addition to the airframe or power-plant curriculum subjects (or both).

Appendix A to Part 147-Curriculum Requirements

This appendix defines terms used in Appendices B, C, D of this part, and describes the levels of proficiency at which items under each subject in each curriculum must be taught, as outlined in Appendices B, C, and D.

- (a) Definitions. As used in Appendices B, C, and D:
 - (1) "Inspect" means to examine by sight and touch.
 - (2) "Check" means to verify proper operation.
 - (3) "Troubleshoot" means to analyze and identify malfunctions
 - (4) "Service" means to perform functions that assure continued operation.
 - (5) "Repair" means to correct a defective condition. Repair of an airframe or powerplant system includes component replacement and adjustment, but not component repair.
 - (6) "Overhaul" means to disassemble, inspect, repair as necessary, and check.

- (b) Teaching levels.
 - (1) Level one requires:
 - (i) Knowledge of general principles, but no practical application.
 - (ii) No development of manipulative skill.
 - (iii) Instruction by lecture, demonstration, and discussion.
 - (2) Level two requires:
 - (i) Knowledge of general principles, and limited practical application.
 - (ii) Development of sufficient manipulative skill to perform basic operations.
 - (iii) Instruction by lecture, demonstration, discussion, and limited practical application.
 - (3) Level three requires:
 - (i) Knowledge of general principles, and performance of a high degree of practical application.
 - (ii) Development of sufficient manipulative skill to accomplish return to service.
 - (iii) Instruction by lecture, demonstration, discussion, and a high degree of practical application.

Appendix B to part 147—General-Curriculum Subjects

Must be at least 400 hours in length.

FAA Certification: Aircraft General Technology (700–711)

Standard 700: Basic Electricity

Students will understand basic electricity and its application to aircraft. Students will perform calculations of and service electrical systems at the proficiency level specified by *FAA, Part 147: Appendix B*.

Standard 701: Aircraft Drawings

Students will understand aircraft drawings and schematic diagrams. Students use and make aircraft drawings and schematic diagrams at the proficiency level specified by *FAA, Part 147: Appendix B*.

Standard 702: Weight and Balance

Students will understand weight and balance and their application to aircraft. Students will perform weight and balance checks on an aircraft at the proficiency level specified by *FAA, Part 147: Appendix B*.

Standard 703: Fluid Lines and Fittings

Students will understand the hydraulic systems and components used in aircraft. Students will fabricate and install rigid and flexible fluid lines and fittings at the proficiency level specified by *FAA, Part 147: Appendix B*.

Standard 704: Materials and Processes

Students will understand aircraft materials, heat treating, and nondestructive testing methods. Students will identify and select aircraft hardware and materials, perform heat-treating processes, and perform nondestructive-testing processes at the proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 705: Ground Operation and Servicing

Students will understand aircraft ground-operation and service procedures. Students will ground-operate and service aircraft at the proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 706: Cleaning and Corrosion Control

Students will understand aircraft cleaning and corrosion-control procedures. Students will clean and perform corrosion-control procedures on aircraft at the proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 707: Mathematics

Students will understand mathematics as it applies to aircraft. Students will perform mathematics operations on aircraft at a proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 708: Maintenance Forms and Records

Students will understand maintenance forms and records and their importance to aircraft reliability. Students will describe aircraft conditions, describe the work performed, and complete the required maintenance forms and records at the proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 709: Basic Physics

Students will understand the physics of simple machines, sound, fluid, and heat dynamics. Students will use the principles of simple machines, sound, fluids, and heat dynamics at the proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 710: Maintenance Publications

Students will understand how to use aircraft maintenance publications. Students will use aircraft maintenance publications to the proficiency level specified by *FAA*, Part 147: Appendix B.

Standard 711: Mechanics Privileges and Limitations

Students will understand the privileges and limitations of aircraft mechanics, as specified by *FAA*, Part 147: Appendix B.

FAA Aircraft Airframe (720-736)

Standard 720: Wood Structures

Students will understand the construction details of aircraft wood structures. Students will service and repair aircraft wood structures at the proficiency level specified by *FAA*, Part 147: Appendix C.

Standard 721: Aircraft Coverings

Students will know the materials and processes used in aircraft coverings. Students will inspect, test, and repair fabric and fiberglass coverings at the proficiency level specified by *FAA, Part 147: Appendix C*.

Standard 722: Aircraft Finishes

Students will understand the application, materials, and processes used in aircraft finishes. Students will apply aircraft finishes at the proficiency level specified in *FAA, Part 147: Appendix C*.

Standard 723: Sheet-Metal Structures

Students will understand the use of sheet metal in aircraft. Students will inspect and repair aircraft sheet-metal components at the proficiency level specified by *FAA, Part 147: Appendix C*.

Standard 724: Welding

Students will understand the principles of welding and soldering various metals. Students will weld or solder various metals at the proficiency level specified in *FAA, Part 147: Appendix C*.

Standard 725: Assembly and Rigging

Students will understand the principles involved in the assembly and rigging of aircraft. Students will rig rotor and fixed-wing aircraft, align structures, and balance and rig movable surfaces at the proficiency level specified in *FAA, Part 147: Appendix C*.

Standard 726: Airframe Inspections

Students will understand the purposes of and procedures for airframe inspections. Students will perform airframe-conformity and airworthiness inspections at the proficiency level specified in *FAA, Part 147: Appendix C*.

Standard 727: Landing-Gear Systems

Students will understand aircraft landing-gear systems and components. Students will inspect, check, service, and repair landing gear, retraction systems, shock struts, brakes, wheels, tires, and steering systems at the proficiency level specified in *FAA, Part 147: Appendix C*.

Standard 728: Hydraulic-Power and Pneumatic-Power Systems

Students will understand the principles and components of aircraft hydraulic-power and pneumatic-power systems. Students will inspect, check, service, troubleshoot, and repair hydraulic-power and pneumatic-power systems at the proficiency level specified in *FAA, Part 147: Appendix C*.

Standard 729: Cabin Atmosphere-Control Systems

Students will understand cabin atmosphere-control systems and components. Students will inspect, check, service, and repair heating, cooling, air-conditioning, pressurization, and oxygen systems at the proficiency level specified by *FAA, Part 147: Appendix C*.

Standard 730: Aircraft Instrument Systems

Students will understand aircraft instrument systems and components. Students will inspect, check, service, troubleshoot, and repair heading-, speed-, altitude-, attitude-, time-, temperature-,

pressure-, and position-indicating systems at the level of proficiency specified by *FAA*, Part 147: Appendix C.

Standard 731: Communication and Navigation Systems

Students will understand the components and operation of aircraft-communication and navigation systems. Students will inspect, check, service, troubleshoot, and repair autopilot, approach-control, electronic-communication, and navigation systems at the proficiency level specified by *FAA*, Part 147: Appendix C.

Standard 732: Aircraft Fuel Systems

Students will understand the components and operation of aircraft fuel systems. Students will inspect, check, service, troubleshoot, and repair aircraft fuel systems at the proficiency level specified by *FAA*, Part 147: Appendix C.

Standard 733: Aircraft Electrical Systems

Students will understand the components and operation of aircraft electrical systems. Students will inspect, check-service, troubleshoot, and repair AC and DC current systems at the proficiency level specified by *FAA*, Part 147: Appendix C.

Standard 734: Position and Warning Systems

Students will understand the components and operation of position and warning systems for takeoff, electrical brakes, antiskid, and landing gear. Students will inspect, check, service, troubleshoot, and repair position and warning systems at the proficiency level specified by *FAA*, Part 147: Appendix C.

Standard 735: Ice-Control and Rain-Control Systems

Students will understand the operation and components of ice-control and rain-control systems. Students will inspect, check, service, troubleshoot, and repair ice-control and rain-control systems at the proficiency level specified by *FAA*, Part 147: Appendix C.

Standard 736: Fire-Protection Systems

Students will understand the operation and components of fire-protection systems, including smoke- and carbon monoxide-detection systems and fire-detection and extinguishing systems. Students will inspect, check, service, troubleshoot, and repair fire-protection systems at the proficiency level specified by *FAA*, Part 147: Appendix C.

FAA Aircraft Powerplants (740–755)

Standard 740: Reciprocating Engines

Students will understand the components and operation of aircraft reciprocating engines. Students will inspect, check, service, troubleshoot, and repair aircraft reciprocating engines at the proficiency level specified by *FAA*, Part 147: Appendix D.

Standard 741: Turbine Engines

Students will understand the operation and components of aircraft turbine engines. Students will inspect, check, service, troubleshoot, repair, and overhaul aircraft turbine engines at the proficiency level specified by *FAA*, Part 147: Appendix D.

Standard 742: Engine Inspection

Students will understand engine-inspection procedures for each component of reciprocating and turbine engines. Students will perform power-plant conformity and airworthiness inspections at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 743: Engine Instrument Systems

Students will understand the operation and components used in engine instrumentation for fluid (rate of fuel flow), engine temperature, pressure, and r.p.m. indicating systems. Students will inspect, check, troubleshoot, and repair engine-instrument systems at the proficiency level specified in *FAA, Part 147: Appendix D*.

Standard 744: Engine Fire-Protection Systems

Students will understand the components and operation of engine fire-protection systems. Students will inspect, check, service, troubleshoot, and repair engine fire-detection and extinguishing systems at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 745: Engine Electrical Systems

Students will understand the operation and components used in engine electrical systems. Students will install, inspect, check, service, troubleshoot, and repair electrical wiring, controls, switches, indicators, and protective devices at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 746: Engine Lubrication Systems

Students will understand the components and operation of engine lubrication systems and lubricants. Students identify lubricants and repair engine lubrication systems at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 747: Ignition Systems

Students will understand the components and operation of ignition systems for reciprocating and turbine engines. Students will overhaul magneto and ignition harnesses and inspect, check, service, troubleshoot, and repair reciprocating-engine and turbine-engine ignition systems at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 748: Fuel-Metering Systems

Students will understand the components and operation of fuel-metering and water-metering systems. Students will inspect, check, service, troubleshoot, and repair water-injection, reciprocating-engine, and turbine-engine fuel-metering systems at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 749: Engine-Fuel Systems

Students will understand the components and operation of engine-fuel systems. Students will inspect, check, service, troubleshoot, and repair engine-fuel systems at the proficiency level specified by *FAA, Part 147: Appendix D*.

Standard 750: Induction Systems

Students will understand the components and operation of engine-induction systems. Students will inspect, check, service, troubleshoot, and repair engine ice-control and rain-control systems,

heat exchangers and superchargers, carburetors, and air-intake and induction systems at the proficiency level specified by *FAA*, Part 147: Appendix D.

Standard 751: Cooling Systems

Students will understand the parts and operation of aircraft engine-cooling systems. Students will inspect, check, service, troubleshoot, and repair aircraft-cooling systems at the proficiency level specified by *FAA*, Part 147: Appendix D.

Standard 752: Engine-Exhaust Systems

Students will understand the components and operation of aircraft engine-exhaust systems. Students will inspect, check, service, troubleshoot, and repair engine-exhaust systems at the proficiency level specified by *FAA*, Part 147: Appendix D.

Standard 753: Propellers

Students will understand components and operation of propellers and related systems. Students will inspect, check, service, and repair propeller-synchronizing and ice-control systems; identify propeller lubricants; balance propellers; and repair fixed-pitch, constant-speed, and feathering propellers and propeller-governing systems at the proficiency level specified by *FAA*, Part 147: Appendix D.

Standard 754: Unducted Fans

Students will understand the components and operation of unducted-fan systems. Students will inspect and troubleshoot unducted-fan systems and components at the level specified in *FAA*, Part 147: Appendix D,

Standard 755: Auxiliary Power Units

Students will understand the components and operation of auxiliary power units. Students will inspect, check, service, and troubleshoot turbine-driven auxiliary power units at the level specified in *FAA*, Part 147: Appendix D.

Motorcycle Repair (800–817)

Standard 800: Introduction to Motorcycle Repair

Students will understand entry-level job assignments for motorcycle-repair technicians. Students will analyze the knowledge and skills needed for job entry and advancement and will evaluate their potential as repair technicians and managers. Students will handle simulated confrontational experiences in the work environment, fill out work orders, and document repairs.

Standard 801: Safety

Students will understand the importance of working safely, the major causes of accidents, the correct use of tools and equipment, and the guidelines for lifting objects safely. Students will analyze typical hazards found in motorcycle shops, apply first aid to common injuries, and locate the material-supply data sheets (MSDS) for the hazardous materials found in motorcycle-repair facilities.

Standard 802: Tools and Equipment

Students will understand the need for special tools (tools with a single or limited application to motorcycles) and the major equipment used in motorcycle-repair facilities. Students will use special tools and equipment in various applications.

Standard 803: Metrics and Precision Measurements

Students will understand how to use the metric-measuring system. Students will perform specific measurements to 1/100 mm, using the precision-measuring instruments used in the motorcycle industry.

Standard 804: Motorcycle Engines

Students will understand the theories and scientific principles involved in two-stroke and four-stroke engines. Students will disassemble and reassemble two-stroke and four-stroke engines and conduct compression and leak-down tests.

Standard 805: Battery and Electrical Service

Students will understand the design, purposes, and functions of the electrical systems on a motorcycle. Students will explain the basic service procedures for each motorcycle electrical system in accordance with industry standards.

Standard 806: Fuel Systems

Students will understand the scientific principles of fuel systems, including carburetion and fuel injection. Students will diagnose and service fuel-system components in accordance with industry standards.

Standard 807: Wheels and Tires

Students will understand the functions and purposes of wheel and tire assemblies and will diagnose wheel and tire problems.

Standard 808: Steering and Suspension Service

Students will understand the functions of motorcycle-steering, front- and rear-suspension, and rear-wheel-drive systems. Students will perform steering and suspension servicing in accordance with factory specifications.

Standard 809: Brakes

Students will understand the theory, purpose, function, and operation of motorcycle-braking systems. Students will inspect breaks for wear, replace brake shoes and pads, and handle brake fluid correctly.

Standard 810: Clutch

Students will understand the operation of the clutch and its components. Students will diagnose mechanical- and hydraulic-clutch dysfunction, perform repairs, and make clutch adjustments in accordance with industry standards.

Standard 811: Starting Systems

Students will understand the purpose and operation of kick-, electric-, and recoil-starting systems for motorcycles. Students will diagnose and service those systems in accordance with industry standards.

Standard 812: Ignition Performance

Students will understand the purpose for the ignition system and the operation of various types of ignition systems. Students will use modern test equipment to diagnose and service ignition systems in accordance with industry standards.

Standard 813: Engine Performance

Students will understand the purpose of doing engine-performance work and the sequence of tasks to be followed. Students will perform each of the tasks involved in engine performance.

Standard 814: Chassis Maintenance

Students will understand the purpose of chassis maintenance and the procedures to be followed. Students will perform the tasks involved in chassis maintenance, including control-cable routing and service.

Standard 815: Pre-Delivery Assembly and Preparation

Students will understand the procedures for pre-delivery assembly and preparation of new motorcycles. Students will uncrate, assemble, and prepare a new motorcycle for delivery.

Standard 816: Top-End Service

Students will understand the steps involved in performing top-end service on two-stroke and four-stroke engines. Students will disassemble, clean, inspect for wear, and reassemble a one-cylinder, four-stroke engine.

Standard 817: Fasteners

Students will know the purposes of various types of fasteners used in the motorcycle industry. They will measure, select, install, repair, and remove fasteners as needed for various repair jobs.

Model Curriculum Integrated Performance Activities

Standards in all the industrial and technology education curriculum clusters are written as broad-based performance standards. Integrated performance activities describe classroom or workplace student activities that reflect two or more performance standards. They are specifically intended to provide instructors and curriculum developers with examples of activities designed to promote the student's acquisition of selected standards. Classroom teachers will have the option of using the integrated performance activities as developed here or modifying them to fit local needs, objectives, or individual teaching styles.

A limited selection of integrated performance activities is provided in this document to facilitate an understanding of performance standards. Subsequent and companion handbooks or curriculum development guides will provide a complete reference to integrated performance activities for all industrial and technology education curriculum clusters. Integrated performance activities are subject to constant change, including additions, item corrections and rewrites, deletions, and the like. Integrated performance activities are subject to constant modification to keep pace with the changing needs of students, business and industry, and the educational milieu.

Selected activities are as follows (draft copies of an activities handbook are available on request from consultants listed on pages xiii and xiv):

Activity 3: Breadboard Construction of Electrical Circuits

Each student is given a breadboard, hook-up wire, electrical components, electrical-schematic diagrams, a 13.5-volt power source, and a multimeter. The students build the electrical circuits, each typical of those found in automobiles, as specified in the schematic diagrams.

Students are supplied with analysis work sheets for each schematic circuit. Students must use the multimeter to measure volts, ohms, and amps in strategic parts of the live circuits in order to answer some of the questions on the work sheet. Other questions require the students to use Ohm's law to find specific values for components as used in a live circuit.

Transportation and Energy Standards	2, 3, 4, 10, 11, 17, 25
Career Performance Standards	3, 7
Academic Performance Standards	2, 12, 13, 20, 21, 22, 40

Air-Cooled Gas Engine

Activity 6: Engine Assembly

Students work in teams of three. Each team member takes on a particular role: one is a parts-identification and factory-manual information specialist, another is a tuneup and specifications specialist, and the last member of the team is an assembly specialist. The instructor provides a job description for each specialty area, appropriate audiovisual training materials, and industry training courses to help students understand their role on the team. Interaction between teams is encouraged to further define the role and duties of each specialist.

The instructor presents to each team a box containing a completely disassembled engine, with the parts in random order. Students are told that four key parts are missing from each engine. Each team must determine which parts are missing and order from the instructor the needed parts, using a dealer purchase order and the proper part numbers. Each team assembles, adjusts, and test runs its engine.

The proper identification of the four missing parts, correct assembly, and an engine that meets factory operating specifications are the criteria used by the instructor to evaluate the performance of each team.

Transportation and Energy Standards	3, 18, 21, 38, 39, 40, 41, 42, 43, 45, 46
Career Performance Standards	2, 3, 5, 7
Academic Performance Standards	2, 3, 11, 12, 20, 21, 22, 40

Activity 10: The Great Parts Mystery

Unlabeled air-cooled gasoline-engine parts are presented to the class. In one or more boxes, all of the parts from five different model engines (made by four different engine manufacturers) are mixed up. The students divide into five teams; and, in a blind-rotational selection process, each team picks parts out of the boxes until the boxes are empty.

The teams are instructed to use catalogs, repair manuals, microfiche cards, and measurement tools to identify each "mystery part." Each part must be identified by name, part number, function, manufacturer, and the particular engine model on which the part is to be installed.

Each team creates a catalog of its parts. The teams share their catalogs and exchange parts, enabling each team to assemble one of the five engines. After assembly and adjustment, each team test runs its engine for the class.

Transportation and Energy Standards 3, 18, 38, 39, 40, 41, 42, 43, 45, 46

Career Performance Standards 2, 3, 4, 5, 7

Academic Performance Standards 10, 20, 21, 22, 40

Activity 11: Engine Governor Adjustment

Each student is presented with an air-cooled gasoline engine in which the governor has been tampered with and found to be out of adjustment. Using the procedures outlined in the factory manual, students check and repair the governor assembly. Before the engine is started, the required static-governor adjustments are made. With the engine running at operating temperature and with the correct fuel mixture, students adjust the top no-load-governed speed for that engine. The students file reports, specifying the condition of the governor when the engine was received and the specifications to which all adjustments were made.

Transportation and Energy Standards 3, 18, 20, 38, 40, 41, 42, 43

Career Performance Standards 3, 4, 5, 7

Academic Performance Standards 20, 21, 22, 40

ASE Certification: Engine Repair

Activity 100: Engine Repair

ROP/community college students in an open-laboratory environment work in teams of three or four. One team performs service-writer functions, greets customers; listens to customer complaints about automotive malfunctions; and prepares cost estimates (using industry pricing and repair codes to identify the work) in accordance with the Bureau of Automotive Repair regulations. Another team prepares a technician's work order, listing customer complaints and the desired repairs; using industry repair codes to identify the work; and assigning the job to the appropriate repair team.

The engine-repair team, on receipt of the technician's work order, verifies customer complaints, removes the engine from the vehicle, disassembles the engine, cleans the components, and performs precision measurements to determine the condition of the components.

Students prepare a list of the required replacement parts, machine work, and sublet services; revise the initial cost estimate; and contact the customer. After receiving approval from the customer to continue, students will machine the components as necessary; replace defective components; and complete the reassembly, using industry-accepted procedures, equivalent tools and equipment, specifications, and torque values. The students reinstall the engine in the vehicle and perform final adjustments.

The students inspect and retest the vehicle to ensure that all necessary repairs have been accomplished and close the repair order by returning it to the service writer, who prepares the final repair order for the customer.

The instructor inspects and monitors all cleaning, disassembly, precision measuring, reassembly, and final adjustments, making comments and demonstrating procedures as needed.

Transportation and Energy Standards	1, 2, 3, 4, 5, 6, 7, 17, 18, 20, 21, 23, 24, 25, 26, 27
Career Performance Standards	1, 2, 3, 4, 5, 7
Academic Performance Standards	2, 3, 10, 12, 13, 20, 21, 22, 30, 40

ASE Certification: Manual Drivetrain and Axles

Activity 150: Clutch and Universal Joints

ROP/community college students work in an open-shop situation in teams of four to perform all the business and repair functions required of a repair facility, in accordance with BAR and industry standards.

Students greet a customer who is complaining of clutch slippage and drivetrain clunks on his four-wheel-drive. They fill out a work order, listing all of the customer's descriptions of the problems. Students look up the cost of the parts and give the customer a written estimate. They have the customer sign the work authorization and liability waiver. Using factory manuals and information systems, students research the inspection and repair procedures for the conditions encountered. They inspect, check, and diagnose the clutch and drivetrain problems. A student then contacts the customer with a revised estimate and obtains the customer's approval to continue the work. The student teams then proceed with the service and repair of the clutch and drivetrain. During the service and repair procedures, the instructor monitors work in progress and makes suggestions to team members regarding their work. Under the supervision of the instructor, the students write out the final repair bill when the work is completed, present the bill to the customer for payment, and explain the work that was done.

Transportation and Energy Standards	1, 2, 3, 4, 5, 18, 19, 20, 21, 78, 79, 80, 81, 82
Career Performance Standards	1, 2, 3, 4, 5, 7
Academic Performance Standards	10, 11, 12, 13, 20, 21, 22, 40

Truck and Diesel

Activity 400: Frame and Glider Kit

ROP/community college students work in an open-laboratory situation in teams of four to perform all business and repair functions in accordance with BAR and trucking-industry standards.

Teams are presented with a class-8 tractor that has been involved in a serious highway accident in which the frame was bent and the cab demolished. Students interview the owner and discuss the various options for repairing the vehicle. The owner decides that because the truck is fairly new and has only 500,000 miles on it, he wants to replace the frame, install a glider kit, and overhaul and repair each of the truck's components as needed. Students research the cost of parts, and the inspection and repair procedures for each component, and give the owner a preliminary estimate. They have the owner sign the repair order and liability waiver. Team members then order the parts needed to start the work.

Team members strip the truck down to the ground, evaluating each component and repairing and rebuilding as needed. The truck is then reassembled by the team. During the rebuilding process the instructor closely monitors the work in progress and makes suggestions to the team regarding its work and the procedures being used. Under the supervision of the instructor, the students write out the bill and present it to the owner when the work is completed.

Transportation and Energy Standards	1, 2, 3, 4, 5, 6, 7, 8, 9, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 113, 114, 115, 116, 117, 118, 119, 120, 121, 123, 124
Career Performance Standards	1, 2, 3, 4, 5, 7
Academic Performance Standards	2, 3, 4, 10, 11, 12, 13, 20, 21, 22, 30, 40

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Glossary of Terms

Articulation. A connected, nonduplicative sequence of instruction in which there are formally defined roles and responsibilities. Students are helped in their transition through an educational program that builds and expands on previous learning experiences.

Career Path(way). The series of educational experiences students complete as they move to achievement of a career goal. Students may begin their career pathways in elementary and middle schools with awareness and exploration programs; they refine their education and career focus as they move through career path cluster and career specialization options in high school and postsecondary programs.

Career Path Cluster. A broad group of related occupations that serves as a focus for career pathway preparation in the high school curriculum. The seven career path clusters in Industrial and Technology Education include construction, drafting, electronics, engineering, graphic communications, manufacturing, and transportation and energy technologies.

Career Performance Standards. The seven workplace readiness skills all students need to master to be successful at work regardless of their chosen field: personal skills, interpersonal skills, thinking and problem solving skills, communication skills, occupational safety, employment literacy skills, and technology literacy skills. Career performance standards are always taught in the specific curricular context of a career pathway.

Career Specialization. A narrow group of occupations that focus on generally requiring postsecondary education.

Career–Technical Assessment Program (C–TAP). A program sponsored by the Far West Laboratory for Educational Research and Development and the California Department of Education. The program serves as a system for the authentic assessment of students. The system uses a portfolio strategy that incorporates both cumulative and on-demand assessment components, including a résumé, letter of introduction, letter of recommendation, work samples, and written scenarios.

Curriculum (Content) Standards. Specific career path cluster criteria that guide curriculum sequence design. Each standard includes a cognitive and a performance component. The cognitive component states what students should know by the end of the career path cluster program. The performance component states what the student should be able to do when applying that knowledge.

Program. A coherent sequence of instruction.

Regional Occupational Centers/Programs (ROCs/Ps). Vocational and technical education designed to prepare students for an increasingly technological society in which generalized training and skills are insufficient to prepare high school students and graduates and out-of-school youths and adults for the many employment opportunities that require special or technical training and skills.

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