ATTACHMENT III
Text of Proposed New 19 TAC

Chapter 127. Texas Essential Knowledge and Skills for Career Development and Career and Technical Education

Subchapter O. Manufacturing [~~Science, Technology, Engineering, and Mathematics~~]

§127.824. Blueprint Reading for Manufacturing Applications (One Credit), Adopted 2025.

(a) Implementation.

(1) The provisions of this section shall be implemented by school districts beginning with the 2026-2027 school year.

(2) School districts shall implement the employability skills student expectations listed in §127.15(d)(1) of this chapter (relating to Career and Technical Education Employability Skills, Adopted 2025) as an integral part of this course.

(b) General requirements. This course is recommended for students in Grades 9-12. Recommended prerequisites: Algebra I and Geometry. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

(3) In Blueprint Reading for Manufacturing Applications, students gain knowledge and skills in an introduction to reading and interpreting working drawings for basic machining processes, mechanical maintenance, basic electrical, basic fluid power, and basic facility prints. Students also use sketching techniques to create pictorial and multiple-view drawings.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other organizations that foster leadership and career development in the profession such as student chapters of related professional associations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

(1) The student demonstrates an understanding of blueprint and technical drafting terminology and functions. The student is expected to:

(A) explain the function of various parts of a title block such as scale, materials, and print title;

(B) interpret and explain the function of multi-view drawings;

(C) describe fractional, decimal, and metric dimensions used in technical drawings;

(D) interpret and explain the function of section views;

(E) identify and describe projection methods, including isometric, oblique, and orthographic, used in engineering drawings;

(F) explain the function of auxiliary views;

(G) identify and explain types of dimensions, including linear, radial, angular, ordinate, and arc length;

(H) explain the function of pictorial drawings in manufacturing applications;

(I) explain the function of geometric dimensioning and tolerancing in manufacturing applications;

(J) explain tolerances with parts from a print;

(K) explain the function of scaling in a print;

(L) differentiate between a pictorial and a schematic drawing;

(M) explain the function of scaling in a print;

(N) explain the function of call outs in a print; and

(O) differentiate between electrical schematics, fluid power schematics, and piping and instrumentation diagram (P&ID) drawings.

(2) The student demonstrates an understanding of tools and symbols to produce technical schematics, facility prints, P&ID prints, and blueprints. The student is expected to:

(A) explain the function of and use a compass for drawing arcs in a print;

(B) explain the function of and use measuring devices such as scales, micrometers, and dial calipers;

(C) explain and demonstrate basic functions of computer-aided design and drafting (CADD) software;

(D) identify blueprint symbols, including surface profile, position, run out, countersink, and depth symbols;

(E) differentiate between driving and reference dimensions;

(F) identify basic electrical print symbols, including switch, lamp, relay, and contact symbols;

(G) identify basic fluid power print symbols, including power unit, actuator, directional control valve, and flow control symbols;

(H) identify various P&ID symbols, including valve, gauge, meter, and regulator symbols; and

(I) identify symbols for components, including threads, fasteners, and springs, used in the manufacturing process.

(3) The student interprets facility drawings related to manufacturing buildings. The student is expected to:

(A) interpret and explain floor plan drawings;

(B) interpret and explain elevation drawings;

(C) interpret and explain section views and details;

(D) locate electrical components, including distribution panels, lights, switches, and outlets, on facility drawings;

(E) identify plumbing components, including drains, water supply, and boilers, on facility drawings; and

(F) identify heating, ventilation, and air conditioning (HVAC) components, including condensers, evaporators, and plenum, in facility drawings.

(4) The student applies drafting principles to create sketch pictorials and construct multi-view drawings. The student is expected to:

(A) sketch auxiliary projected views, including inclined and oblique surfaces, in pictorial drawings;

(B) create a sketch using multi-views; and

(C) annotate a series of multi-view projections using proper dimensioning standards.

(5) The student demonstrates knowledge of tolerances as applied to technical drawings and prints. The student is expected to:

(A) illustrate and explain how bilateral and unilateral tolerances are expressed in drawings; and

(B) calculate tolerances for mating parts based on maximum material conditions, tolerance stacking, and allowance.

(6) The student demonstrates knowledge of revision information related to drawings. The student is expected to:

(A) describe standard drawing practices such as title blocks, revision history, and change orders for drawing revisions;

(B) apply standard drawing practices to revise technical drawings, ensuring accuracy and compliance with industry standards; and

(C) apply revision information, including date of revision, description of changes, and approval signatures, to mechanical and electrical industrial prints.

§127.828. Industrial Maintenance (One Credit), Adopted 2025.

(a) Implementation.

(1) The provisions of this section shall be implemented by school districts beginning with the 2026-2027 school year.

(2) School districts shall implement the employability skills student expectations listed in §127.15(d)(1) of this chapter (relating to Career and Technical Education Employability Skills, Adopted 2025) as an integral part of this course.

(b) General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: Algebra I or Geometry. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

(3) Industrial Maintenance is designed to introduce students to knowledge and skills used in the proper application of industrial maintenance. The study of manufacturing technology allows students to reinforce, apply, and transfer academic knowledge and skills to a variety of relevant maintenance tasks. Students gain an understanding of what employers require to gain and maintain employment in manufacturing careers.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other organizations that foster leadership and career development in the profession such as student chapters of related professional associations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

(1) The student applies mechanical skills to maintain and repair industrial equipment using the appropriate tools and equipment while adhering to safety policies. The student is expected to:

(A) identify equipment malfunctions using visual, audible, and other sensory inspection skills to detect issues such as lack of lubrication, misalignment, excess wear, vibration, and over-temperature;

(B) differentiate between mechanical, hydraulic, pneumatic, and electrical systems;

(C) identify safety concerns with equipment maintenance such as dangers with rotating equipment, hot surfaces from operating equipment, potential for shock from electrical power cords and grounding, and sharp surfaces from equipment wear;

(D) create a safe plan of action to address safety concerns for an industrial training environment such as sparks, metal shavings, and electrical shock hazards;

(E) identify tools and describe procedures used in cutting, drilling, cleaning, and abrasive processes;

(F) explain safety practices for various types of manufacturing tools used for cutting, drilling, cleaning, and abrasive processes;

(G) identify and demonstrate proper use of precision measuring tools, including micrometers, dial calipers, and scales, to verify proper repair and alignment; and

(H) identify and explain the applications such as material and fastener strength for various types of fasteners such as bolts, screws, washers, and nuts.

(2) The student applies communication and documentation skills to manufacturing activities. The student is expected to:

(A) compose written and oral technical communication such as maintenance plans, equipment breakdowns, and repair part ordering in a clear, concise, and effective manner for a variety of purposes and audiences;

(B) identify documentation methods such as maintenance logbooks and checklists for maintenance tasks and plans; and

(C) develop and execute a plan for maintenance task completion such as equipment lubrication, filter changes, and equipment visual checks.

(3) The student maintains and repairs industrial equipment using the appropriate tools, equipment, machines, materials, and technical processes. The student is expected to:

(A) describe the processes needed to complete a project, including initiating, planning, executing, monitoring, controlling, and closing;

(B) use appropriate tools to complete maintenance repair processes, including drilling, tapping, layout, and tightening fasteners to spec; and

(C) use various wrenches such as open and box end wrenches, filter wrenches, and adjustable pliers to disassemble filter housings to change filters and fluids.

(4) The student understands the foundations of occupational safety and health. The student is expected to:

(A) explain and discuss the responsibilities of workers and employers to promote safety and health and the rights of workers to a secure workplace;

(B) explain and discuss the importance of Occupational Safety and Health Administration (OSHA) standards and OSHA requirements for organizations;

(C) explain and discuss how OSHA inspections are conducted;

(D) explain and discuss the role of national and state safety and health regulatory entities;

(E) explain types of industrial hygiene hazards, including physical, chemical, biological, and ergonomic, and explain the role industrial hygiene plays in occupational safety;

(F) identify and explain the appropriate use of types of personal protective equipment (PPE) used in industry;

(G) discuss the importance of safe walking and working surfaces and best practices for preventing or reducing slips, trips, and falls in the workplace;

(H) describe types of electrical hazards in the workplace;

(I) describe control methods to prevent electrical hazards in the workplace;

(J) analyze the hazards of handling, storing, using, and transporting hazardous materials;

(K) discuss ways to reduce exposure to hazardous materials in the workplace;

(L) identify workplace health and safety resources, including emergency plans and Safety Data Sheets (SDS), and discuss how these resources are used to make decisions in the workplace;

(M) describe elements of a safety and health program, including management leadership, worker participation, and education and training;

(N) explain the purpose and importance of written emergency action and fire protection plans;

(O) describe key components of evacuation plans, emergency exit routes, and fire hazards lists;

(P) explain the role of emergency personnel within an organization;

(Q) explain components of a hazard communication program; and

(R) explain and provide examples of safety and health training requirements specified by standard setting organizations.

(5) The student examines safe work habits in an industrial maintenance setting. The student is expected to:

(A) identify and describe proper storage and disposal procedures for hazardous materials using Material Safety Data Sheets (MSDS);

(B) identify and demonstrate use of proper PPE and safety requirements in the manufacturing industry such as hearing protection, eye protection, and gloves;

(C) describe and demonstrate proper lockout/tagout procedures;

(D) describe and demonstrate safe operation of power tools, including drills, saws, grinders, and sanders; and

(E) identify and select appropriate PPE needed to operate various power tools, including drills, saws, grinders, and sanders.

(6) The student examines the importance of preventative maintenance in an industrial maintenance environment. The student is expected to:

(A) perform preventative maintenance (PM), including lubrication, cleaning of parts, and tightening of fasteners, on equipment such as motors, gearboxes, chain drives, and conveyors;

(B) determine a PM schedule based on data collected from machine breakdowns, including frequency of failures, types of malfunctions, and repair times; and

(C) differentiate between reactive maintenance such as breakdown repairs, preventative maintenance such as lubrication, and predictive maintenance such as planning repairs based on previous breakdown frequencies.

(7) The student examines career opportunities and educational requirements in manufacturing and technology. The student is expected to:

(A) identify special skill career pathways in manufacturing such as maintenance technician, engineer, designer, and automation technician;

(B) identify and explain the importance of industry networking opportunities such as career or job fairs; and

(C) describe the roles and functions of engineers, technologists, and technicians in an industrial maintenance setting.

§127.829. Mechanical Maintenance (One Credit), Adopted 2025.

(a) Implementation.

(1) The provisions of this section shall be implemented by school districts beginning with the 2026-2027 school year.

(2) School districts shall implement the employability skills student expectations listed in §127.15(d)(2) of this chapter (relating to Career and Technical Education Employability Skills, Adopted 2025) as an integral part of this course.

(b) General requirements. This course is recommended for students in Grades 10-12. Prerequisite: at least one credit in a course from the Manufacturing Career Cluster. Recommended prerequisite: Algebra I or Geometry. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

(3) Mechanical Maintenance is designed to introduce students to knowledge and skills used in the proper application of mechanical maintenance. The study of mechanical maintenance and hands-on application allows students to reinforce, apply, and transfer academic knowledge and skills to a variety of relevant activities. Students gain an understanding of what employers require to gain and maintain employment in manufacturing careers and potential hazards faced by the maintenance technician in an industrial setting.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other organizations that foster leadership and career development in the profession such as student chapters of related professional associations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

(1) The student understands the foundations of occupational safety and health. The student is expected to:

(A) explain and discuss the responsibilities of workers and employers to promote safety and health and the rights of workers to a secure workplace;

(B) explain and discuss the importance of Occupational Safety and Health Administration (OSHA) standards and OSHA requirements for organizations;

(C) explain and discuss the importance of how OSHA inspections are conducted;

(D) explain and discuss the role of national and state regulatory entities;

(E) explain the role industrial hygiene plays in occupational safety and explain types of industrial hygiene hazards, including physical, chemical, biological, and ergonomic;

(F) identify and explain personal protective equipment (PPE) used in industry;

(G) discuss the importance of safe walking and working surfaces in the workplace;

(H) discuss best practices for preventing or reducing slips, trips, and falls in the workplace;

(I) describe types of electrical hazards in the workplace and the risks associated with these hazards;

(J) describe control methods to prevent electrical hazards in the workplace;

(K) analyze the hazards of handling, storing, using, and transporting hazardous materials;

(L) identify and discuss ways to reduce exposure to hazardous materials in the workplace;

(M) identify workplace health and safety resources, including emergency plans and Safety Data Sheets (SDS), and discuss how these resources are used to make decisions in the workplace;

(N) describe elements of a safety and health program, including management leadership, worker participation, and education and training;

(O) explain the purpose and importance of written emergency action plans and fire protection plans;

(P) describe key components of evacuation plans, emergency exit routes, fire hazards lists;

(Q) explain the role of emergency personnel within an organization;

(R) explain components of a hazard communication program; and

(S) explain and provide examples of safety and health training requirements specified by standard setting organizations such as OSHA and industrial companies.

(2) The student demonstrates safe work habits while performing mechanical activities in a mechanical maintenance setting. The student is expected to:

(A) identify and describe proper storage and disposal procedures for hazardous materials using Material Safety Data Sheets (MSDS);

(B) identify and demonstrate use of proper PPE, including ear plugs, safety glasses, dust masks, and respirators, in the manufacturing industry;

(C) describe and demonstrate proper lockout/tagout procedures;

(D) describe and demonstrate safe operation of hand tools needed for disassembly and reassembly of mechanical parts; and

(E) identify and select appropriate PPE needed to operate various hand tools, including gloves for protection from pinch points, sharp edges, and hot surfaces.

(3) The student examines the operation of various pumps. The student is expected to:

(A) identify components of a centrifugal pump, including vane, internal seals, and bearings;

(B) identify components of a positive displacement piston pump, including rings, seals, pistons, and crankshaft;

(C) identify components of a positive displacement diaphragm pump, including diaphragm, check valves, and internal seals;

(D) explain the function of a pressure tank and effects on flow with a diaphragm pump;

(E) explain and demonstrate how to fill a suction line to prime a pump;

(F) identify components of a check valve in pumps; and

(G) explain the function of a check valve in maintaining pump priming by preventing back flow and ensuring fluid flow.

(4) The student examines the operation of various compressors. The student is expected to:

(A) identify components of compressors, including the piston, crankshaft, and cylinders, and explain how these components work together to compress air;

(B) explain the operation of a piston compressor and how the components work together to increase pressure;

(C) differentiate between a single-stage and two-stage piston compressor;

(D) identify and explain the function of intercoolers in two-stage piston compressors;

(E) identify and explain the function of after coolers in two-stage piston compressors;

(F) identify components of a rotary screw compressor, including screws, compression chamber, intake valves, and discharge valves;

(G) explain the operation of a rotary screw compressor and how the components work together to increase pressure; and

(H) explain the importance of dryers with industrial compressors, including how dryers prevent corrosion, improve efficiency, and extend equipment lifespan.

(5) The student analyzes test or performance data to assess equipment operation. The student is expected to:

(A) inspect equipment parts, including bearings, bolts, housing, and shafts, to identify typical defects such as breakage or excessive wear;

(B) observe equipment in operation to check for potential problems such as leaks, misalignment, and overheating; and

(C) test mechanical equipment to ensure proper functioning of equipment after replacement or repair of parts.

(6) The student uses prints, specifications, and diagrams to perform installation, disassembly, and assembly of mechanical systems. The student is expected to:

(A) identify components of pumps, compressors, and mechanical drives in mechanical drawings and diagrams;

(B) apply torque to fasteners as prescribed in equipment manuals during reassembly;

(C) identify input and output capability of pumps and compressors according to manufacturer specifications;

(D) identify input and output speed and torque capability of belt, chain, and gear driven mechanical drives systems according to manufacturer specifications;

(E) locate part numbers using a diagram; and

(F) use a logbook or computer to record information about parts, materials, and repair procedures.

(7) The student uses industrial maintenance skills to safely disassemble and assemble various types of pumps for the purpose of maintenance and repair. The student is expected to:

(A) identify safety hazards, including electrical, mechanical, and thermal risks, associated with assembly and disassembly of pumps;

(B) explain the purpose of lockout/tagout procedures for pumps to reduce electrical, mechanical, and thermal hazards;

(C) identify tools and describe procedures used in the disassembly and assembly of a centrifugal pump;

(D) identify tools and describe procedures used in the disassembly and assembly of a diaphragm pump;

(E) inspect pumps to locate damage, defects, and wear;

(F) operate pumps to ensure correct function such as rotation direction, prime, and flow;

(G) explain and demonstrate proper lubrication procedures for pumps; and

(H) use a logbook or computer to record information about parts, materials, and repair procedures.

(8) The student uses industrial maintenance skills to safely disassemble and assemble various types of compressors for the purpose of maintenance and repair. The student is expected to:

(A) identify safety hazards, including electrical, mechanical, and thermal risks, associated with assembly and disassembly of compressors;

(B) explain the purpose of lockout/tagout procedures for compressors to reduce electrical, mechanical, and thermal hazards;

(C) identify tools and describe procedures used in the disassembly and assembly of a reciprocating compressor;

(D) identify tools and describe procedures used in the disassembly and assembly of a rotary screw compressor;

(E) inspect compressors to locate damage, defects, and wear;

(F) operate newly reassembled compressor to ensure correct function such as direction of rotation;

(G) explain and demonstrate proper lubrication procedures for compressors; and

(H) use a logbook or computer to record information about parts, materials, and repair procedures.

(9) The student examines and recognizes internal components of various pumps and compressors. The student is expected to:

(A) identify internal seals and vanes in various compressors and pumps, including centrifugal, vane, and diaphragm pumps;

(B) inspect vanes in a centrifugal pump for wear and damage;

(C) inspect internal seals in pumps and compressors for wear and damage;

(D) inspect diaphragm for damage, defects, and wear;

(E) identify bearings on pumps and compressors; and

(F) inspect bearings on pumps and compressors for damage and wear.

(10) The student understands the purpose of specific internal components of various pumps and compressors. The student is expected to:

(A) explain the purpose of internal seals on compressors and pumps;

(B) explain the function and operation of bearings on compressors and pumps;

(C) identify and explain the function of check valves in a diaphragm pump; and

(D) explain lubrication requirements for pumps and compressors.

(11) The student understands the purpose of specific internal components of gear boxes. The student is expected to:

(A) identify and explain the function of spur gears in mechanical drive systems;

(B) identify and explain the function of helical gears in mechanical drive systems;

(C) identify and explain the function of miter and bevel gears in mechanical drive systems;

(D) differentiate between miter and bevel gears in mechanical drive systems; and

(E) identify and explain the function of slingers for lubrication distribution in mechanical drive systems.

(12) The student applies industrial maintenance skills to safely disassemble and assemble various types of mechanical drives. The student is expected to:

(A) identify tools and describe procedures used in the disassembly and assembly of belt, chain, and gear driven mechanical drives; and

(B) identify safety hazards associated with assembly and disassembly of belt, chain, and gear driven mechanical drives.

(13) The student understands the use of drive belts and chains for speed control. The student is expected to:

(A) identify belt style, size, and application on a mechanical drive system to meet speed and torque specifications;

(B) identify proper sheave for belt application on a mechanical drive system;

(C) differentiate between a drive and driven sheave in mechanical drive systems;

(D) calculate sheave ratios for speed adjustments on a mechanical drive system;

(E) inspect sheave and belt for wear and possible replacement on a mechanical drive system;

(F) identify drive chain size to match sprocket used on a mechanical drive system;

(G) calculate sprocket ratios for speed adjustments on a mechanical drive system;

(H) adjust chain length by breaking roller chain with special chain breaking tools;

(I) assemble a chain on a mechanical drive system according to length and tension requirements; and

(J) inspect sprocket and chain for wear and possible replacement on a mechanical drive system.

(14) The student examines career opportunities and educational requirements in manufacturing and technology. The student is expected to:

(A) identify special skill career pathways in manufacturing such as an industrial maintenance technician, mechanical installer, mechanical repair, and mechanical troubleshooter;

(B) identify and explain the importance of industry networking opportunities such as career or job fairs; and

(C) describe the roles and functions of an industrial maintenance technician in manufacturing.

§127.830. Basic Fluid Power (One Credit), Adopted 2025.

(a) Implementation.

(1) The provisions of this section shall be implemented by school districts beginning with the 2026-2027 school year.

(2) School districts shall implement the employability skills student expectations listed in §127.15(d)(2) of this chapter (relating to Career and Technical Education Employability Skills, Adopted 2025) as an integral part of this course.

(b) General requirements. This course is recommended for students in Grades 10-12. Prerequisite: at least one credit in a course from the Manufacturing Career Cluster. Recommended prerequisites: Algebra I and Geometry. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

(3) In Basic Fluid Power, students gain knowledge and skills in hydraulic and pneumatic systems as applied to industrial manufacturing. Instruction includes terminology and fluid power theory, interpreting technical drawings, component identification, mathematical calculations as applied to fluid power systems, and component functions. Students gain basic knowledge of fluid power system design with basic system components, installing basic fluid power system components, and building maintenance schedules for preventative and reactive maintenance.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other organizations that foster leadership and career development in the profession such as student chapters of related professional associations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

(1) The student examines career opportunities and safety concerns in the manufacturing industry. The student is expected to:

(A) research and describe trends of manufacturing careers in industry; and

(B) identify safety, health, environmental, and ergonomic issues in the manufacturing industry.

(2) The student examines terminology and fundamental concepts of fluid power in manufacturing. The student is expected to:

(A) explain the function of Pascal's Law in hydraulic systems;

(B) identify and explain the function of actuators in fluid power systems;

(C) identify and explain the function of valves in fluid power systems;

(D) describe the relationship between pressure, force, and cylinder volume in fluid power systems;

(E) analyze the application of Gay Lussac's Law, Charles's Law, and Boyle's Law in pneumatic systems;

(F) explain how the law of conservation of energy applies to specific fluid power systems, including hydraulic and pneumatic systems;

(G) explain how pressure is generated in a fluid power circuit;

(H) explain how different seal types and operating temperatures can impact fluid compatibility;

(I) explain the difference between flash point, fire point, and auto ignition regarding hydraulic fluid;

(J) explain displacement regarding hydraulic pumps; and

(K) identify specific hazards such as high-pressure injection injuries and equipment damage resulting from unrelieved pressure in the lines of a fluid power system.

(3) The student reads and interprets technical drawings in a fluid power system. The student is expected to:

(A) identify common fluid power symbols, including cylinders, motors, pumps, reservoirs, and directional control valves;

(B) differentiate between schematic and pictorial diagrams;

(C) match fluid power schematic symbols to physical components in a system;

(D) construct and operate a basic fluid power circuit given a schematic with a directional control valve and a double-acting cylinder; and

(E) draw a fluid power schematic from a given fluid power application.

(4) The student demonstrates understanding of the characteristics and applications of fluid power systems. The student is expected to:

(A) analyze pressure gauge readings to identify potential internal and external leakage issues in fluid power systems;

(B) analyze flow meters to detect proper and improper system flow in fluid power systems;

(C) analyze temperature gauges to detect heat issues within fluid power systems;

(D) explain the operational difference between hydraulic and pneumatic systems;

(E) explain the importance of dryers in pneumatic systems, including the prevention of moisture-related issues; and

(F) explain the importance of lubrication in a pneumatic system, including the reduction of friction, prevention of wear and tear, and enhancement of system efficiency.

(5) The student applies mathematical calculations to various operations of a fluid power system. The student is expected to:

(A) describe and analyze pressure, force, and volume in the context of fluid power systems;

(B) calculate output force and rod speed given cylinder size, flow rate, and pressure applied;

(C) describe and calculate how a change in pressure or volume results in change in force;

(D) describe and calculate how change in volume results in change of rod speed and force applied; and

(E) calculate the force output of an extending cylinder using Pascal's Law.

(6) The student understands the function of various components in fluid power systems. The student is expected to:

(A) differentiate between a pneumatic compressor and a hydraulic pump;

(B) describe the functions of a hydraulic reservoir such as fluid storage, fluid cooling, and contaminant separation;

(C) describe the function of various pumps, including piston, gear, and vane pumps;

(D) differentiate between a fixed and variable displacement pump;

(E) explain the purpose of an actuator in fluid power systems;

(F) explain the purpose of various gauges and meters in fluid power systems;

(G) explain the purpose of various pressure controlling devices in hydraulic systems, including pressure relief valves, pressure reducing valves, sequence valves, and counterbalance valves;

(H) explain the purpose of various pressure controlling devices in pneumatic systems, including regulators and pressure relief valves;

(I) explain the purpose of various flow controlling devices in fluid power systems, including check valves, directional control valves, needle valves, and flow controls;

(J) explain the purpose of various motors in fluid power systems, including unidirectional and bi-directional motors;

(K) describe the function of hydraulic and pneumatic actuators, including motor, cylinder, and rotary actuators;

(L) describe the function of various hydraulic and pneumatic cylinders, including single- and double-acting, single- and double-rod, and rodless cylinders;

(M) describe the function of a fluid power double-acting cylinder;

(N) describe and analyze the function of flow control valves in regulating actuator speed in a fluid power circuit;

(O) identify and explain the function of a check valve; and

(P) explain the function of an accumulator.

(7) The student designs basic fluid power circuits using various components in a fluid power system. The student is expected to:

(A) design a fluid power circuit with a unidirectional motor;

(B) design a fluid power circuit with a bi-directional motor;

(C) design a fluid power circuit with multiple cylinders;

(D) design a fluid power circuit with a flow control valve to regulate actuator speed;

(E) design a fluid power circuit incorporating a check valve;

(F) design a basic fluid power circuit incorporating various configurations of directional control valves to alter flow direction;

(G) design fluid power circuits using various operators for directional control, including lever, solenoid, pilot, and push button operator;

(H) design a hydraulic sequence valve to operate multiple actuators in sequence; and

(I) design a hydraulic pressure reducing valve to lower pressure in a branch circuit.

(8) The student installs various components in a fluid power system. The student is expected to:

(A) connect fluid power circuits using various connecting methods, including threaded, push-fit, and quick disconnect fittings;

(B) identify and demonstrate proper safety procedures required for system installation such as lockout/tagout to control hazardous energy;

(C) install a fluid power circuit with a unidirectional motor;

(D) install a fluid power circuit with a bi-directional motor;

(E) install a fluid power circuit with multiple cylinders;

(F) install a fluid power circuit with a flow control valve to regulate actuator speed;

(G) install a fluid power circuit using a check valve;

(H) install a basic fluid power circuit using various configurations of directional control valves to change flow direction;

(I) install fluid power circuits using various operators for the directional control valve, including lever, solenoid, pilot, and push button operator;

(J) install and adjust a pneumatic system regulator to match a defined system pressure setting;

(K) install and adjust a hydraulic power unit relief valve to match a defined system pressure setting;

(L) install a hydraulic sequence valve to operate multiple actuators in sequence; and

(M) install a hydraulic pressure reducing valve to lower pressure in a branch circuit.

(9) The student uses industry standard practices to maintain functional capacity in fluid power systems. The student is expected to:

(A) analyze service data to develop and implement preventive maintenance schedules;

(B) analyze and document repair data to develop and implement predictive maintenance schedules;

(C) inspect components in a fluid power system to identify signs of malfunction, including discoloration, vibration, and loud sounds;

(D) inspect hydraulic fluid to identify contaminants and signs of viscosity breakdown;

(E) explain and demonstrate procedures to change filters in a fluid power system; and

(F) explain and demonstrate procedures to drain and replace hydraulic fluid.

(10) The student understands the function of a basic vacuum system. The student is expected to:

(A) identify and explain the function of a venturi vacuum application;

(B) connect and read a vacuum gauge;

(C) connect and read a manometer;

(D) connect and operate a vacuum generator;

(E) identify and explain the function of a vacuum generator; and

(F) connect a venturi to a pneumatic system.