

Chapter 130. Texas Essential Knowledge and Skills for Career and Technical Education

Subchapter M. Manufacturing

Statutory Authority: The provisions of this Subchapter M issued under the Texas Education Code, §§7.102(c)(4), 28.002, 28.00222, and 28.025, unless otherwise noted.

§130.351. Implementation of Texas Essential Knowledge and Skills for Manufacturing, Adopted 2015.

(a)

(1)

- (A) demonstrate effective oral and written communication skills with individuals from varied cultures, including fellow workers, management, and customers;
 - (B) interpret engineering drawings, charts, diagrams, and welding symbols; and
 - (C) select algebraic and geometric principles and formulas required for precision measuring operations.
- (3) The student differentiates between the technical concepts that form the knowledge and skills of manufacturing. The student is expected to:
- (A) use tools and equipment commonly employed in manufacturing in a safe manner;
 - (B) demonstrate an understanding of the safety regulations for the different types of manufacturing equipment such as cutting, abrasive, boring, turning, shaping, and forming tools;
 - (C) execute procedures using the different types of manufacturing equipment such as cutting, abrasive, boring, turning, shaping, and forming tools;
 - (D) research the modern materials used in manufacturing; and
 - (E) perform varied measurements, including precision measurements.
- (4) The student investigates emerging and innovative applications of technology in engineering. The student is expected to:
- (A) report on innovative applications of technology in engineering;
 - (B) experiment with new technologies; and
 - (C) experiment with different manufacturing materials such as plastic, composites, fiberglass, stone, and wood.
- (5) The student manufactures products or systems using the appropriate tools, equipment, machines, materials, and technical processes. The student is expected to:
- (A) analyze the processes needed to complete a project such as initiate, plan, execute, monitor and control, and close; and
 - (B) use a variety of equipment and machines to produce an item to specification.
- (6) The student practices safe work habits. The student is expected to:
- (A) master safety tests developed from Occupational Safety and Health Administration regulations;
 - (B) analyze hazardous materials;
 - (C) dispose of hazardous materials safely; and
 - (D) store all materials correctly.
- (7) The student participates in a mass manufacturing project. The student is expected to:
- (A) participate in the manufacturing of a mass produced project; and
 - (B) develop a method to check and maintain quality control throughout the manufacturing process.
- (8) The student identifies the factors that influence the cost of an item or service. The student is expected to:
- (A) develop a budget for a project; and
 - (B) determine the most effective strategies to minimize costs.

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- (D) identify employers' work expectations;
- (E) use time-management techniques to develop work schedules;
- (F) explore advanced knowledge and skills required for postsecondary education; and
- (G) identify employers' expectations to foster positive customer satisfaction.

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- (4) Students are encouraged t

- (A) use teamwork to solve problems;
 - (B) demonstrate a work ethic that meets common employers' expectations;
 - (C) use time-management techniques to develop work schedules;
 - (D) describe how teams measure results;
 - (E) demonstrate the skills required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
 - (F) communicate effectively with others in the workplace to clarify objectives; and
 - (G) apply skills related to health and safety in the workplace as specified by appropriate governmental regulations.
- (2) The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
- (A) apply mathematics to problems arising in everyday life, society, and the workplace;
 - (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;
 - (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;
 - (D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;
 - (E) create and use representations to organize, record, and communicate mathematical ideas;
 - (F) analyze mathematical relationships to connect and communicate mathematical ideas; and
 - (G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.
- (3) The student applies design skills to manufacturing. The student is expected to:
- (A) use computer-aided design (CAD) software to complete a design;
 - (B) analyze the results of product testing in a simulated modeling environment;
 - (C) fabricate a prototype design of a mechanical part; and
 - (D) use computer-integrated manufacturing techniques to simulate a manufacturing process.
- (4) The student performs functions and solves problems in the electricity and electronics field. The student is expected to:
- (A) develop solutions to use control devices; and
 - (B) troubleshoot control devices such as programmable logic circuit devices.

- (6) The student demonstrates an understanding of mechanical and fluid systems. The student is expected to:
 - (A) use mechanical devices;
 - (B) use pneumatics devices; and
 - (C) use hydraulics devices.
- (7) The student demonstrates an understanding of electrical and thermal systems. The student is expected to:
 - (A) use electrical controls;
 - (B) analyze the effects of heat energy and temperature on products; and
 - (C) develop an understanding of ventilation such as heating, air conditioning, and refrigeration.
- (8) The student analyzes quality-control systems. The student is expected to:
 - (A) apply statistical process control;
 - (B) determine hardness values of different materials; and
 - (C) analyze attribute and Pareto charts.
- (9) The student develops a system using electrical controls and pneumatics or hydraulics devices. The student is expected to:
 - (A) design a system that incorporates electrical controls and either a pneumatic or hydraulic device;
 - (B) build a system that incorporates electrical controls and either a pneumatic or hydraulic device; and
 - (C) test and troubleshoot the system that incorporates electrical controls and either a pneumatic or hydraulic device.

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- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
 - (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.
- (c) Knowledge and skills.
- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) determine advanced knowledge and skills required to gain industry-recognized certifications;
 - (B) identify

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- (B) demonstrate knowledge of computer numerical control (CNC) machines;
- (C) demonstrate knowledge of the concepts of automated welding machines;

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- (C) demonstrate acceptable work ethics in reporting for duty and performing assigned tasks as directed;
 - (D) conduct oneself in a manner acceptable for the profession and work site such as suitable dress and polite speech;
 - (E) choose the ethical course of action and comply with all applicable rules, laws, and regulations;
 - (F) review the fine, detailed aspects of both quantitative and qualitative work processes and end products;
 - (G) evaluate systems and operations; identify causes, problems, patterns, or issues; and explore workable solutions or remedies to improve situations;
 - (H) follow written and oral instructions and adhere to established business practices, policies, and procedures, including health and safety rules; and
 - (I) prioritize tasks, follow schedules, and work toward goal-relevant activities in an effective, efficient manner.
- (2) The student explores the employability characteristics of a successful worker in the global economy. The student is expected to:
- (A) determine academic knowledge and skills required for postsecondary education;
 - (B) identify employers' expectations to foster positive customer satisfaction;
 - (C) demonstrate the professional standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-

- (5) The student evaluates the function and application of the tools, equipment, technologies, and materials used in precision machining. The student is expected to:
 - (A) practice safety while running equipment commonly employed in machine shops;
 - (B)

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- (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) Precision Metal Manufacturing II will provide students the knowledge, skills, and technologies required for employment in precision machining. While this course is designed to provide necessary skills in machining, it also provides a real-world foundation for any engineering discipline. This course addresses a variety of materials such as plastics, ceramics, and wood in addition to metal. Students will develop knowledge of the concepts and skills related to these

- (C) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
 - (D) evaluate progress toward personal career goals;
 - (E) communicate effectively with others in the workplace to clarify objectives; and
 - (F) demonstrate skills related to health and safety in the workplace as specified by appropriate governmental regulations.
- (3) The student applies the technical knowledge and skills of advanced precision metal manufacturing. The student is expected to:
- (A) apply the technical aspects found in *The Machinery's Handbook* resource; and
 - (B)

- (A) perform various types of tool changes;
 - (B) demonstrate quick change tooling used on CNC milling machines;
 - (C) demonstrate appropriate tool storage;
 - (D) demonstrate the proper use of tool offset registers;
 - (E) determine tool offset length; and
 - (F) incorporate tool offsets for a set up.
- (9) The student operates a CNC lathe. The student is expected to:
- (A) use equipment commonly associated with a CNC lathe in a safe manner;
 - (B) recognize, name, and describe the function of the primary components of a CNC lathe;
 - (C) perform preventative maintenance checks on a CNC lathe such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;
 - (D) test the coolant for proper density and adjust accordingly in order to reach the correct mixture;
 - (E) perform a power up on a standard CNC lathe;
 - (F) demonstrate the use of the jog controls on the operator panel to jog the lathe's axes;
 - (G) demonstrate the ability to locate, assemble, and measure tooling according to work instructions and job documentation;
 - (H) install

- (J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;
 - (K) set the proper geometry/tool offsets for each tool in a standard tool-setting process;
 - (L) operate a CNC mill in automatic mode; and
 - (M) illustrate the proper power down process on a CNC mill.
- (11) The student learns to manually program a CNC lathe without the help of computer-aided design or manufacturing (CAD/CAM) software. The student is expected to:
- (A) calculate trigonometry to determine coordinates from technical drawings to cut arcs and angles;
 - (B) use trigono

- (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

- (B) demonstrate knowledge of welding currents;
 - (C) apply shielded metal arc welding principles;
 - (D) demonstrate proper set-up procedure for shielded metal arc welding;
 - (E) determine appropriate electrodes for base metal in shielded metal arc welding;
 - (F) perform fillet and groove welds in all positions; and
 - (G) prepare joints for welding.
- (9) The student performs gas metal arc welding principles and practices. The student is expected to:
- (A) use safe operating practices;
 - (B) apply gas metal arc welding principles;
 - (C) demonstrate proper set-up procedure for gas metal arc welding;
 - (D) use appropriate equipment setup for base metal in gas metal arc welding; and
 - (E) perform fillet and groove welds using gas metal arc welding with various metal transfer processes.

Source: The provisions of this §130.362 adopted to be effective August 28, 2017, 40 TexReg 6601.

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- (C) demonstrate acceptable work ethics in reporting for duty and performing assigned tasks as directed;
- (D) conduct oneself in a manner acceptable for the profession and work site such as suitable dress and polite speech;
- (E) choose the ethical course of action and comply with all applicable rules, laws, and regulations;
- (F) review the fine, detailed aspects of both quantitative and qualitative work process and end products;
- (G) evaluate systems and operations; identify causes, problems, patterns, or issues; and explore workable solutions or remedies to improve situations;
- (H)

- (A) operate welding equipment according to safety standards;
 - (B) identify and properly dispose of environmentally hazardous materials used in welding;
 - (C) explain the importance of recycling materials used in welding;
 - (D) choose appropriate personal protective equipment; and
 - (E) evaluate skills related to health and safety in the workplace as specified by appropriate governmental regulations.
- (5) The student understands welding joint design, symbols, and welds. The student is expected to:
- (A) demonstrate knowledge of engineering drawings, charts, and diagrams;
 - (B) interpret orthographic and isometric views of three-dimensional figures;
 - (C) interpret engineering, drawings, charts, and diagrams;
 - (D) analyze components of the welding symbol;
 - (E) identify types of welding joints;
 - (F) identify positions of welding; and
 - (G) identify types of welds such as fillet, groove, spot, plug, and flanged.
- (6) The student analyzes the concepts and intricacies of inspections and related codes. The student is expected to:
- (A) explain weld inspection processes; and
 - (B) interpret welding codes.
- (7) The student analyzes oxy-fuel cutting processes on carbon steels. The student is expected to:
- (A) practice safe operating practices;
 - (B) perform safe handling of compressed gases;
 - (C) identify components of oxy-fuel gas cutting system;
 - (D) demonstrate proper set-up procedures for oxy-fuel cutting process;
 - (E) identify factors affecting oxy-fuel cutting of base metals;
 - (F) demonstrate proper cutting techniques such as piercing, straight line, and bevel;
 - (G) identify acceptable cuts; and
 - (H) evaluate alternative fuel gasses such as propane, propylene, and Chemtane 2®.
- (8) The student analyzes plasma arc cutting on metals. The student is expected to:
- (A) use safe operating practices;
 - (B) demonstrate knowledge of the theories of plasma arc cutting;
 - (C) apply safe handling of compressed air supply;
 - (D) identify components of plasma arc cutting;
 - (E) demonstrate correct set-up procedure for plasma arc cutting;
 - (F) define cutting terms; and
 - (G) perform straight line, piercing, bevels, and shape cuts.
- (9) The student analyzes shielded metal arc welding principles and practices on metals. The student is expected to:
- (A) use safe operating practices;

- (B) analyze welding current relationships such as alternating current and direct current, heat transfer, and polarity;
- (C) apply shielded metal arc welding principles;
- (D) demonstrate proper set-up procedure for shielded metal arc welding;
- (E) explain the American Welding Society (AWS) identification system for shielded metal arc welding electrodes;
- (F) determine appropriate electrodes for base metal in shielded metal arc welding; and
- (G) perform multi-0.001

- (A) determine academic knowledge and skills required for postsecondary education;
 - (B) identify employers' expectations to foster positive customer satisfaction;
 - (C) demonstrate the professional standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
 - (D) evaluate progress toward personal career goals;
 - (E) communicate effectively with others in the workplace to clarify objectives; and
 - (F) apply knowledge and skills related to health and safety in the workplace as specified by appropriate governmental regulations.
- (3) The student applies academic skills to the requirements of welding. The student is expected to:
- (A) demonstrate mathematical skills to estimate costs;
 - (B) explain the impact of accurate readings of measuring devices on cost estimates;
 - (C) justify the selection of a tool to make accurate measurements;
 - (D) compute measurements such as area, surface area, volume, and perimeter;
 - (E) solve problems using whole numbers, fractions, mixed numbers, and decimals;
 - (F) apply right triangle relationships using the Pythagorean Theorem; and
 - (G) select a mathematical formula for estimation.
- (4) The student knows the functions and applications of the tools, equipment, technologies, and materials used in welding. The student is expected to:
- (A) use welding equipment according to safety standards;
 - (B) dispose of environmentally hazardous materials used in welding;
 - (C) explain the importance of recycling materials used in welding;
 - (D) evaluate the performance impact of emerging technologies in welding;
 - (E) use appropriate personal protective equipment to follow safety measures; and
 - (F) investigate the use of automated welding machines such as numerical control, computer numerical control, and robotics-controlled welding machines.
- (5) The student illustrates welding joint design, symbols, and welds. The student is expected to:
- (A) use knowledge of engineering drawings to complete an advanced project; and
 - (B) evaluate projects using engineering drawing specifications.
- (6) The student applies the concepts and skills of welding to perform tasks. The student is expected to:
- (A) work independently in fabricating welded projects;
 - (B) work collaboratively with other students to complete a real-world application item; and
 - (C) troubleshoot equipment.
- (7) The student analyzes the concepts and intricacies of inspections related to welding codes. The student is expected to:
- (A) inspect the welding projects of team members;
 - (B) select codes for weld inspections; and
 - (C) critique and evaluate the weldments of team members.
- (8) The student performs advanced cutting processes on carbon steels. The student is expected to:

- (A) observe safe operating practices;
 - (B) apply safe handling of compressed gases; and
 - (C) perform cutting processes according to accepted welding standards.
- (9) The student performs shielded metal arc welding on metals. The student is expected to:
- (A) employ safe operating practices; and
 - (B) demonstrate skills required to make welds in all positions according to industry-accepted welding standards.
- (10) The student performs flux cored metal arc welding. The student is expected to:
- (A) use safe operating practices;
 - (B) perform fillet and groove welds; and
 - (C) perform welds in all appropriate positions according to to industry-accepted welding standards.
- (11) The student performs gas tungsten arc welding on metals. The student is expected to:
- (A) employ safe operating practices;
 - (B) perform fillet and groove welds in all positions; and
 - (C) perform welds on metals such as carbon steel, stainless steel, pipe, and aluminum according to industry-accepted welding standards.

Source: The provisions of this §130.364 adopted to be effective August 28, 2017, 40 TexReg 6601; amended to be effective March 27, 2018, 43 TexReg 1852.

§130.365. Welding II Lab (One Credit), Adopted 2015.

- (a) General requirements. This lab course is recommended for students in Grades 11 and 12. Prerequisite: Welding I. Corequisite: Welding II.

- (A) use safe operating practices;
 - (B) perform safe handling of compressed gases;
 - (C) assemble components involved in setting up for oxy-fuel gas cutting processes;
 - (D) demonstrate proper set-up for cutting techniques such as piercing, straight line, and bevel; and
 - (E) evaluate acceptable and unacceptable cuts.
- (6) The student performs plasma arc cutting on metals. The student is expected to:
- (A) use safe operating practices;
 - (B) explain the difference between safe and unsafe storage and handling of compressed gas supply;
 - (C) employ proper set-up procedures for plasma arc cutting; and
 - (D) demonstrate proper cutting techniques, including straight line, piercing, and bevels.
- (7) The student performs shielded metal arc welding principles and practices on metals. The student is expected to:
- (A) use safe operating practices;
 - (B) demonstrate shielded metal arc welding principles;
 - (C) demonstrate proper set-up procedures for shielded metal arc welding;
 - (D) select appropriate electrodes for base metal in shielded metal arc welding;
 - (E) perform welds such as fillet and groove according to industry-accepted welding standards;
 - (F) perform multiple pass welds;
 - (G) prepare joints for welding; and
 - (H) explain heating processes such as pre-heating and post-heating.
- (8) The student demonstrates proper set-up procedure for gas metal arc welding. The student is expected to:
- (A) use safe operating practices;
 - (B) demonstrate gas metal arc welding principles;
 - (C) demonstrate proper set-up for gas metal arc welding;
 - (D) select appropriate filler metals for base metal in gas metal arc welding; and
 - (E) select appropriate filler metals for base metal in gas metal arc welding; and

- (10) The student performs gas tungsten arc welding principles and practices on metals. The student is expected to:
 - (A) use safe operating practices;
 - (B) demonstrate gas tungsten arc welding principles;
 - (C) demonstrate proper set-up for gas tungsten arc welding;
 - (D) select appropriate use of filler metals for base metal in gas tungsten arc welding; and
 - (E) perform welds in all appropriate positions according to industry-accepted welding standards.
- (11) The student performs weldment fabrications. The student is expected to:
 - (A) identify layout tools;
 - (B) perform a part layout on plate according to a blueprint;
 - (C) perform a layout of a pipe fitting according to a blueprint; and
 - (D) perform an assembly according to a blueprint.

Source: The provisions of this §130.365 adopted to be effective August 28, 2017, 40 TexReg 6601; amended to be effective March 27, 2018, 43 TexReg 1852.

§130.366. Practicum in Manufacturing (Two Credits), Adopted 2015.

- (a) General requirements. This course is recommended for students in Grade 12. The practicum course is a paid or unpaid capstone experience for students participating in a coherent sequence of career and technical education courses in the Manufacturing Career Cluster. Students shall be awarded two credits for successful completion of this course. A student may repeat this course once for credit provided that the student is experiencing different aspects of the industry and demonstrating proficiency in additional and more advanced knowledge and skills.
- (b) 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) The Practicum in Manufacturing course is designed to give students supervised practical application of previously studied knowledge and skills. Practicum experiences can occur in a variety of locations appropriate to the nature and level of experience.
 - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
 - (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.
- (c) Knowledge and skills.
 - (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) identify and apply the employer's standard operating procedures;
 - (B) demonstrate positive work behaviors such as attitudes, punctuality, time management, initiative, and cooperation;

- (C) communicate appropriately and accept constructive criticism;
 - (D) research and discuss business ethics;
 - (E) complete tasks such as quality products and services with the highest standards;
 - (F) model professional appearance such as dress, grooming, and personal protective equipment as appropriate; and
 - (G) comply with safety rules such as regulations to maintain safe working conditions and environments appropriate to the work setting.
- (2) The student applies concepts of critical thinking and problem solving. The student is expected to:
- (A) analyze elements of a problem;
 - (B) analyze information critically to determine its value; and
 - (C) conduct technical research to gather information for decision making.
- (3) The student demonstrates leadership and teamwork skills in collaborating with others to accomplish goals and objectives. The student is expected to:
- (A) analyze leadership characteristics such as trust, positive attitude, integrity, and willingness to accept key responsibilities in a work situation;
 - (B) demonstrate teamwork skills through working cooperatively with others to achieve tasks;
 - (C) demonstrate teamwork processes such as promoting team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution;
 - (D) demonstrate responsibility for organization tasks such as shared group and individual work tasks; and
 - (E) establish and maintain effective working relationships.
- (4) The student demonstrates oral and written communication skills.

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- (B) participate in training, education, or preparation for licensure, certification, or other relevant credentials to prepare for employment;
 - (C) demonstrate professional standards and personal qualities needed to be employable such as self-discipline, positive attitude, integrity, leadership, appreciation for diversity, customer service, work ethic, and adaptability with increased fluency;
 - (D) use personal information management, email, Internet, writing and publishing, presentation, and spreadsheet or database applications with increased fluency;
 - (E) employ teamwork and conflict-management skills with increased fluency to achieve collective goals; and
 - (F) employ planning and time-management skills and tools with increased fluency to enhance results and complete work tasks.
- (2) The student implements advanced professional communications strategies. The student is expected to:
- (A) demonstrate verbal and non-verbal communication consistently in a clear, concise, and effective manner;
 - (B) analyze, interpret, and effectively communicate information, data, and observations;
 - (C) observe and interpret verbal and nonverbal cues and behaviors to enhance communication; and
 - (D) apply active listening skills to obtain and clarify information.
- (3) The student applies concepts of critical thinking and problem solving. The student is expected to:
- (A) employ critical-thinking skills with increased fluency both independently and in groups to solve problems and make decisions;
 - (B) analyze elements of a problem to develop creative and innovative solutions; and
 - (C) conduct technical research to gather information necessary for decision making.
- (4) The student understands and applies proper safety techniques in the workplace. The stsarm9(iTJ 0.006 Tc 0.001 Tw

- (E) collect representative work samples.

Source: The provisions of this §130.367 adopted to be effective August 28, 2017, 41 TexReg 614.