Energy Technologies Program of Study with Complementary Course Standards

This document was prepared by:

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Vision

All Nevada students are equipped and feel empowered to attain their vision of success

Mission

To improve student achievement and educator effectiveness by ensuring opportunities, facilitating learning, and promoting excellence

Nevada Department of Education
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Acknowledgements

The development of Nevada career and technical education (CTE) standards and assessments is a collaborative effort sponsored by the Nevada Department of Education (NDE) Office of Career Readiness, Adult Learning, and Education Options. The Nevada Department of Education relies on educators and industry representatives who have the technical expertise and teaching experience to develop standards and performance indicators that truly measure student skill attainment. More importantly, the NDE would like to recognize the time and commitment by the writing team members in developing the career and technical standards for Energy Technologies.

Standards Development Members

Name	Occupation/Title	Stakeholder Affiliation	School/Organization
Justin Anderson	President/CEO	Business and Industry Representative	Terra Contracting, North Las Vegas
Dustin Coli	Instructor	Secondary Education	Wooster High School, Reno
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Business and Industry Validation

All CTE standards developed through the Nevada Department of Education are validated by business and industry through one or more of the following processes: (1) the standards are developed by a team consisting of business and industry representatives, or (2) a separate review panel is coordinated with industry experts to ensure the standards include the proper content, or (3) nationally recognized standards currently endorsed by business and industry.

The Energy Technologies standards were validated through active participation of business and industry representatives on the development team.

Introduction

The standards in this document are designed to clearly state what the student should know and be able to do upon completion of a high school Energy Technologies program of study. These standards are designed for a two-credit course sequence that prepares the student for a technical assessment directly aligned to the standards.

These exit-level standards are designed for the student to complete all standards through their completion of a program of study. These standards are intended to guide curriculum objectives for a program of study.

The standards are organized as follows:

- **Content Standards** are general statements that identify major areas of knowledge, understanding, and the skills students are expected to learn in key subject and career areas by the end of the program.
- **Performance Standards** follow each content standard. Performance standards identify the more specific components of each content standard and define the expected abilities of students within each content standard.
- **Performance Indicators** are very specific criteria statements for determining whether a student meets the performance standard. Performance indicators may also be used as learning outcomes, which teachers can identify as they plan their program learning objectives. The indicators are followed by designations that reflect the course sequence (e.g., L1 for the first-year course of a two-year program and L2 for the second-year course, C is to designate the indicators to be taught in the complementary course) as referenced in the Core Course Sequence table.

The crosswalks and alignments are located in the Program Supplemental Program Resources document. These will show where the performance indicators support the Nevada Academic Content Standards. For individual course descriptions, please reference the Supplemental Program Resource or the Nevada CTE Catalog.

All students are encouraged to participate in the career and technical student organization (CTSO) that relates to the Energy Technologies program. CTSOs are co-curricular national organizations that directly reinforce learning in the CTE classroom through curriculum resources, competitive events, and leadership development. CTSOs provide students the ability to apply academic and technical knowledge, develop communication and teamwork skills, and cultivate leadership skills to ensure college and career readiness.

The Employability Skills for Career Readiness identify the skills needed to be successful in all careers and must be taught as an integrated component of all CTE course sequences. These standards are available in a separate document.

The **Standards Reference Code** is only used to identify or align performance indicators listed in the standards to daily lesson plans, curriculum documents, or national standards. The Standards Reference Code is an abbreviated name for the program, and the content standard, performance standard and performance indicator are referenced in the program standards. This abbreviated code for identifying standards uses each of these items. For example, ENRGY is the Standards Reference Code for Energy Technologies. For Content Standard 2, Performance Standard 3 and Performance Indicator 4 the Standards Reference Code would be ENRGY.2.3.4.

Energy Technologies

Program Information

Program of Study: Energy Technologies
Standards Reference Code: ENRGY
Career Cluster: Science, Technology, Engineering, and Mathematics
Career Pathway(s): Engineering and Technology
Program Length: 2-year, completed sequentially
CTSO: SkillsUSA

Program Structure Required Program of Study Courses

The core course sequencing is provided in the following table. Complementary Courses are available and provided later in this document. The following courses provide a completed program of study. The Lab is a complementary course available concurrently with the Energy Technologies II course.

Core Course Sequence (R) with Lab Course(s) (C)

Required/ Complementary	Course Title	Abbreviated Name
R	Energy Technologies I	ENERGY TECH I
R	Energy Technologies II	ENERGY TECH II
C	Energy Technologies II LAB	ENERGY TECH II L

CONTENT STANDARD 1.0: INTEGRATE CAREER AND TECHNICAL STUDENT ORGANIZATIONS (CTSOs)

Performance Standard 1.1: Explore the History and Organization of CTSOs

1.1.1 Discuss the requirements of CTSO participation/involvement as described in Carl D. Perkins Law (Level 1 (L1), Level 2 (L2), Complementary (C))

1.1.2 Research nationally recognized CTSOs (L1, L2, C)

1.1.3 Investigate the impact of federal and state government regarding the progression and operation of CTSOs (e.g., Federal Statutes and Regulations, Nevada Administrative Code [NAC], Nevada Revised Statutes [NRS]) (L1, L2, C)

Performance Standard 1.2: Develop Leadership Skills

1.2.1 Discuss the purpose of parliamentary procedure (L1, L2, C)

1.2.2 Demonstrate the proper use of parliamentary procedure (L1, L2, C)

1.2.3 Differentiate between an office and a committee (L1, L2, C)

1.2.4 Discuss the importance of participation in local, regional, state, and national conferences, events, and competitions (L1, L2, C)

1.2.5 Participate in local, regional, state, or national conferences, events, or competitions (L1, L2, C)

1.2.6 Describe the importance of a constitution and bylaws to the operation of a CTSO chapter (L1, L2, C)

Performance Standard 1.3: Participate in Community Service

1.3.1 Explore opportunities in community service-related work-based learning (WBL) (L1, L2, C)

1.3.2 Participate in a service learning (program related) and/or community service project or activity (L1, L2, C)

1.3.3 Engage with business and industry partners for community service (L1, L2, C)

Performance Standard 1.4: Develop Professional and Career Skills

1.4.1 Demonstrate college and career readiness (e.g., applications, resumes, interview skills, presentation skills) (L1, L2, C)

1.4.2 Describe the appropriate professional/workplace attire and its importance (L1, L2, C)

1.4.3 Investigate industry-standard credentials/certifications available within this Career Cluster™ (L1, L2, C)

1.4.4 Participate in authentic contextualized instructional activities (L1, L2, C)

1.4.5 Demonstrate technical skills in various student organization activities/events (L1, L2, C)

Performance Standard 1.5: Understand the Relevance of Career and Technical Education (CTE)

1.5.1 Make a connection between program standards to career pathway(s) (L1, L2, C)

1.5.2 Explain the importance of participation and completion of a program of study (L1, L2, C)

1.5.3 Promote community awareness of local student organizations associated with CTE programs (L1, L2, C)

CONTENT STANDARD 2.0: IDENTIFY LAB ORGANIZATION AND SAFETY PROCEDURES

Performance Standard 2.1: Demonstrate General Lab Safety Rules and Procedures

2.1.1 Describe general shop safety rules and procedures (L1, L2)

2.1.2 Demonstrate knowledge of Occupational Safety and Health Administration (OSHA)/Environmental Protection Agency (EPA) and their role in workplace safety (L1, L2)

2.1.3 Identify safety requirements of different working conditions (e.g., scenarios such as height, confined spaces, chemicals present) (L1, L2)

2.1.4 Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities (i.e., personal protective equipment – PPE) (L1, L2)

2.1.5 Utilize safe procedures for handling of tools and equipment (L1, L2)

2.1.6 Operate lab equipment according to safety guidelines (L1, L2)

2.1.7 Identify and use proper lifting procedures and proper use of support equipment (L1, L2)

2.1.8 Utilize proper ventilation procedures for working within the lab/shop area (L1, L2)

2.1.9 Identify marked safety areas (L1, L2)

2.1.10 Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment for different situations (L1, L2)

2.1.11 Identify the location and use of eye wash stations (L1, L2)

2.1.12 Identify the location of the posted evacuation routes (L1, L2)

2.1.13 Identify and wear appropriate clothing for lab/shop activities (L1, L2)

2.1.14 Secure hair and jewelry for lab/shop activities (L1, L2)

2.1.15 Demonstrate knowledge of the safety aspects of low and high voltage circuits (L1, L2)

2.1.16 Locate and interpret safety data sheets (SDS) (L1, L2)

2.1.17 Prepare time or job cards, reports, or records (L1, L2)

2.1.18 Perform housekeeping duties (L1, L2)

2.1.19 Follow verbal instructions to complete work assignments (L1, L2)

2.1.20 Follow written instructions to complete work assignments (L1, L2)

Performance Standard 2.2: Identify and Utilize Hand Tools

2.2.1 Identify hand tools and their appropriate usage (L1)

2.2.2 Identify standard and metric designation (L1)

2.2.3 Demonstrate the proper techniques when using hand tools (L1)

2.2.4 Demonstrate safe handling and use of appropriate tools (L1)

2.2.5 Demonstrate proper cleaning, storage, and maintenance of tools (L1)

Performance Standard 2.3: Identify and Utilize Power Tools and Equipment

2.3.1 Identify power tools and their appropriate usage (L1)

2.3.2 Identify equipment and their appropriate usage (L1)

2.3.3 Demonstrate the proper techniques when using power tools and equipment (L1)

2.3.4 Demonstrate safe handling and use of appropriate power tools and equipment (L1)

2.3.5 Demonstrate proper cleaning, storage, and maintenance of power tools and equipment (L1)

CONTENT STANDARD 3.0: APPLY THE ENGINEERING DESIGN PROCESS

Performance Standard 3.1: Explore the Design Process of Energy and Power Appliances

- 3.1.1 Identify the design process (L1, L2)
- 3.1.2 Identify the activities that occur during each phase of the design process (L1, L2)
- 3.1.3 Apply the steps of the design process to solve a variety of design problems (L1, L2)
- 3.1.4 Describe how social, environmental, and financial constraints influence the design process (L1, L2)

CONTENT STANDARD 4.0: APPLY BASIC ELECTRICITY CONCEPTS

Performance Standard 4.1: Investigate Basic Electricity Fundamentals

4.1.1 Define electricity (L1)
4.1.2 Describe the basic electrical principles (L1)
4.1.3 Explain the laws of attraction and repulsion and the principle of charge (L1)
4.1.4 Discuss the concepts of current flow, electrical pressure, resistance, and energy (L1)
4.1.5 Describe the relationship of conductor size and length to current flow and resistance (L1)
4.1.6 Identify various electrical units such as voltage, current, resistance, and power (L1)
4.1.7 Summarize electrical static discharge and how it is generated (L1)
4.1.8 Compare and contrast alternating and direct current (AC/DC) (L1)
4.1.9 Identify industry standard symbols (L1)
4.1.10 Create schematic diagrams using proper symbols (L1)
4.1.11 Annotate schematics legibly (L1)

Performance Standard 4.2: Apply Electrical Principles

4.2.1 Demonstrate safe use of electricity and lab equipment (L1)
4.2.2 Demonstrate basic electrical theory (e.g., modify circuits) (L1)
4.2.3 Identify electrical components and their applications (e.g., switches, fuses, relays, resistors, capacitors, inductors, transformers, etc.) (L1, L2)
4.2.4 Utilize tools and test equipment appropriately that are utilized in the electrical industry (e.g., multimeters, wire strippers, power supplies) (L1, L2)
4.2.5 Measure electrical characteristics of voltage, current, and resistance in basic electrical circuits using multimeters (L1, L2)
4.2.6 Calculate Ohm’s Law and power equations (L1, L2)
4.2.7 Construct, measure, and analyze simple series, parallel, and series-parallel (combination) circuits utilizing a schematic, Ohm's Law, and power equations (L1, L2)
4.2.8 Discuss appropriate use of various electrical connections (e.g., crimp connectors, wire nuts, soldering, lugs) (L2)
4.2.9 Design, assemble, and troubleshoot electrical systems using identified components (L2)

CONTENT STANDARD 5.0: INVESTIGATE SOURCES OF ENERGY

Performance Standard 5.1: Identify Sources of Energy

5.1.1 Define energy and name its sources (L1, L2)

5.1.2 Explain how electricity is transmitted, distributed, and stored (L1, L2)

5.1.3 Explain the environmental impacts of producing and distributing electricity and methods used to minimize negative effects (L1, L2)

5.1.4 Investigate career opportunities and training requirements in the energy industry (L1, L2)

5.1.5 Investigate new and emerging technologies that might affect the future of the energy industry (L1, L2)

5.1.6 Design a model and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current (L1, L2)

Performance Standard 5.2: Describe Fossil Fuels

5.2.1 Describe the formation of fossil fuels (i.e., petroleum, coal, natural gas) (L1)

5.2.2 Compare and contrast extraction methods (L1)

5.2.3 Describe availability, allocation, and conservation efforts (L1)

5.2.4 Discuss the advantages and disadvantages of using fossil fuels (L1)

5.2.5 Describe the past, present, and future of fossil fuels (L1)

5.2.6 Evaluate competing design solutions for developing, managing, and utilizing fossil fuels (L1, L2)

Performance Standard 5.3: Describe Solar Energy

5.3.1 Define solar power (L1)

5.3.2 Describe and explain how solar power is generated and harnessed (L1)

5.3.3 Discuss the advantages and disadvantages of solar energy (L1)

5.3.4 Describe the past, present, and future of solar energy (L1)

5.3.5 Evaluate competing design solutions for developing, managing, and utilizing solar energy (L1, L2)

Performance Standard 5.4: Describe Wind Energy

5.4.1 Define wind power (L1)

5.4.2 Explain how wind power is generated and harnessed (L1)

5.4.3 Discuss the advantages and disadvantages of wind energy (L1)

5.4.4 Describe the past, present, and future of wind energy (L1)

5.4.5 Evaluate competing design solutions for developing, managing, and utilizing wind energy (L1, L2)

Performance Standard 5.5: Describe Hydropower Energy

5.5.1 Define hydropower (L1)

5.5.2 Describe and explain how hydropower is generated and harnessed (L1)

5.5.3 Discuss the advantages and disadvantages of hydropower energy (cite a plan) (L1)

5.5.4 Describe the past, present, and future of hydropower energy (L1)

5.5.5 Evaluate competing design solutions for developing, managing, and utilizing hydropower energy (L1, L2)

Performance Standard 5.6: Describe Geothermal Energy

5.6.1 Define geothermal power (L1)

5.6.2 Describe and explain how geothermal power is generated and harnessed (L1)

5.6.3 Discuss the advantages and disadvantages of geothermal energy (L1)

5.6.4 Describe the past, present, and future of geothermal energy (L1)

5.6.5 Evaluate competing design solutions for developing, managing, and utilizing geothermal energy (L1, L2)

Performance Standard 5.7: Describe Biomass Energy

5.7.1 Define biomass power (L1)

5.7.2 Describe and explain how biomass power is generated and harnessed (L1)

5.7.3 Discuss the advantages and disadvantages of biomass energy (L1)

5.7.4 Describe the past, present, and future of biomass for energy (L1)

5.7.5 Evaluate competing design solutions for developing, managing, and utilizing biomass energy (L1, L2)

Performance Standard 5.8: Describe Nuclear Energy

5.8.1 Define nuclear power (L1)

5.8.2 Describe and explain how nuclear power is generated and harnessed (L1)

5.8.3 Discuss the advantages and disadvantages of nuclear energy (L1)

5.8.4 Describe the past, present, and future of nuclear energy (L1)

5.8.5 Evaluate competing design solutions for developing, managing, and utilizing nuclear energy (L1, L2)

Performance Standard 5.9: Apply Knowledge to Model the Uses of Energy

5.9.1 Formulate a plan for implementation for use in one of the listed sources of energy (e.g., wind, solar) (L2)

5.9.2 Design and construct a basic power system (L2)

5.9.3 Test, analyze, and troubleshoot a constructed basic power system (e.g., consumption levels, efficiency, functionality) (L2)

CONTENT STANDARD 6.0: APPLY FUNDAMENTAL ENERGY PRINCIPLES

Performance Standard 6.1: Identify Energy Forms

6.1.1 Identify energy forms (i.e., thermal, radiant, nuclear, chemical, electrical, mechanical) (L1)

6.1.2 Identify units, both standard and metric, used to measure energy and power (e.g., therms, kilowatts, gigajoules) (L2)

6.1.3 Calculate unit conversions between common energy measurements (standard and metric) (L2)

Performance Standard 6.2: Distinguish Potential and Kinetic Energy

6.2.1 Define potential and kinetic energy (L1, L2)

6.2.2 Identify forms of potential and kinetic energy (L1, L2)

6.2.3 Research energy conversions (i.e., potential to kinetic) (L2)

6.2.4 Calculate potential and kinetic energy, including unit conversions (L2)

6.2.5 Design, build, and refine a mechanical device that works within given constraints to model the change from potential to kinetic energy (L2)

Performance Standard 6.3: Identify Transfer of Energy (Thermodynamics)

6.3.1 Define thermodynamics as it relates to transfer and/or conservation of energy (L2)

6.3.2 Investigate the Laws of Thermodynamics (L2)

6.3.3 Demonstrate the concepts of heat transfer (i.e., conduction, convection, radiation) (L2)

Performance Standard 6.4: Use the Design Process to Explore Fundamental Energy Principles

6.4.1 Design, build, and refine a mechanical device that works within given constraints to convert one form of energy into another form of energy (L2)

CONTENT STANDARD 7.0: INVESTIGATE ENERGY EFFICIENCY AND CONSERVATION

Performance Standard 7.1: Identify Efficiency Principles

7.1.1 Define efficiency, conservation, weatherization, and primary building systems (e.g., building shells, window ratings, insulation ratings) (L2)

7.1.2 Describe common terms, units, and usage in residential and commercial buildings as reflected on energy bills (L2)

7.1.3 Describe how energy is used within various sectors of society (e.g., electric vehicles, storage, back-up power supplies) (L2)

7.1.4 Discuss future trends in energy technology (L2)

7.1.5 Explore careers related to building and energy/appliance codes and reasons for implementation of the codes (L2)

7.1.6 Explain the societal, environmental, and economic advantages of energy conservation (L2)

Complementary Courses

State Complementary Skill Standards

State complementary skill standards are designed to clearly state what the student should know and be able to do upon completion of a **one-year** complementary course related to their career and technical education (CTE) program of study. **Completion of the qualifying Program of Study is required prior to enrollment in a complementary course.**

Employability Skills for Career Readiness Standards

Students have completed all program content standards and will pursue advanced study through investigation and in-depth research.

Complementary Course Standards Contributing Members

Course Contribution(s)	Name	Occupation/Title	Stakeholder Affiliation	School/Organization
Energy Technologies Practices	Justin Anderson	President/CEO	Business and Industry Representative	Terra Contracting, North Las Vegas
Energy Technologies Practices	Dustin Coli	Instructor	Secondary Education	Wooster High School, Reno
Energy Technologies Practices	Frank Dolan	Facilities Manager	Business and Industry Representative	Tesla Gigafactory, Sparks
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Energy Technologies Practices	Montez Love	Principal Engineer	Business and Industry Representative	Love Engineering, Las Vegas
Energy Technologies Practices	Leigh Metcalfe	STEM Program Manager	Business and Industry Representative	Governor's Office of Science, Innovation and Technology, Carson City
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The Energy Technologies Practices complementary standards for Energy Technologies program of study were validated through active participation of business and industry representatives on the development team.

Complementary Course Information for Energy Technologies

Program Information

Qualifying Program of Study: **Energy Technologies**
Career Cluster: **Science, Technology, Engineering, and Mathematics**
Career Pathway(s): **Engineering and Technology**
CTSO: **SkillsUSA**
Grade Level: **11-12**

Program Structure for Complementary Courses

The complementary courses are provided in the following table. **The qualifying program of study must be completed prior to enrolling in the complementary courses** (except labs that are done concurrently with the second-year course). A program does not have to utilize the complementary courses for students to complete their program of study.

Complementary Courses

Required/ Complementary	Course Title	Abbreviated Name
C	Energy Technologies Practices	ENERGY TECH PRACT
C	Energy Technologies Advanced Studies	ENERGY TECH AS
C	Industry-Recognized Credential – Energy Technologies	IRC ENERGY TECH
C	CTE Work Experience – Science, Technology, Engineering, and Mathematics	WORK EXPER STEM

Complementary Course Standards
Energy Technologies Practices

CONTENT STANDARD 1.0: INVESTIGATE POWER DISTRIBUTION SYSTEMS

Performance Standard 1.1: Investigate All Parts of the Distribution System

1.1.1 Define all the parts of the distribution system

1.1.2 Describe the function of a wiring system

1.1.3 Explore the materials used for raceways

Performance Standard 1.2: Investigate the Basics of Conduits

1.2.1 Describe the function of a wiring system

1.2.2 Describe the function of the Four Basic Parts of a Wiring System (conductors, raceway, disconnect and over-current protection)

1.2.3 Describe the function of conduit and know the five basic types of conduits (rigid metal conduit, intermediate metal conduit (IMC), Electrical Metallic Tubing (EMT), Non-metallic Conduit (PVC), Liquidtight Flexible Metal Conduit (LFMC))

CONTENT STANDARD 2.0: INTRODUCTION TO BASIC ELECTRICAL CIRCUITS

Performance Standard 2.1: Investigate Electrical Circuit Components

2.1.1 Describe the function of the four basic components of an electrical circuit

2.1.2 Describe the operation of N.O. and N.C. contacts and give their schematic symbols

2.1.3 Describe the function of three types of manual switch operators and give an application of each

2.1.4 Describe the operation of three types of manual switch operators and give their schematic symbols

2.1.5 Connect and operate a circuit using three types of manual switches

Performance Standard 2.2: Investigate Manual Input Devices

2.2.1 Describe the operation of a manual switch

2.2.2 Describe the operation of normally open (N.O.) and normally closed (N.C.) contacts and give their schematic symbols

2.2.3 Describe the function of three types of manual switch operators and give an application of each

2.2.4 Describe the operation of three types of manual switch operators and give their schematic symbols

2.2.5 Connect and operate a circuit using three types of manual switches

CONTENT STANDARD 3.0: INVESTIGATE ELECTRICAL MEASUREMENTS

Performance Standard 3.1: Investigate Voltage Measurement

- 3.1.1 Define voltage and give its units of measurement
- 3.1.2 Describe the function of a voltmeter and give its schematic symbol
- 3.1.3 Describe how to use a voltmeter to measure voltage
- 3.1.4 Use an analog voltmeter to measure the voltage at a point referenced to ground
- 3.1.5 Describe the function of two multimeters: analog and digital
- 3.1.6 Use a digital multimeter (DMM) to measure the voltage of a point referenced to ground

Performance Standard 3.2: Measure Voltage Characteristics within Series and Parallel Circuits

- 3.2.1 Define series and parallel circuits
- 3.2.2 Describe the voltage characteristics in series and parallel circuits
- 3.2.3 Use a DMM to measure voltage drops in series and parallel circuits

Performance Standard 3.3: Investigate Current Measurement

- 3.3.1 Define current and give its units of measurement
- 3.3.2 Describe the function of two types of ammeters and give their schematic symbol
- 3.3.3 Describe how to use an ammeter to measure current
- 3.3.4 Use a DMM to measure the electrical current
- 3.3.5 Use a DMM to measure current in series and parallel circuits
- 3.3.6 Describe the current characteristics in series and parallel circuits

Performance Standard 3.4: Investigate Resistance Measurement

- 3.4.1 Define resistance and give its units of measurement
- 3.4.2 Describe the function of two types of ohmmeters and give their schematic symbol
- 3.4.3 Describe how to use an ohmmeter to measure resistance
- 3.4.4 Use a DMM to measure the resistance of a component
- 3.4.5 Describe the resistance characteristics in series and parallel circuits
- 3.4.6 Measure the resistance in series and parallel circuits
- 3.4.7 Describe two methods of measuring continuity
- 3.4.8 Test the continuity of wires using a DMM

CONTENT STANDARD 4.0: INVESTIGATE POWER IN CIRCUITS

Performance Standard 4.1: Investigate Power in Series Circuits

- 4.1.1 State the Formula for Calculating Series Resistance and Give an Application
- 4.1.2 Calculate Series Resistance Given Each Load's Resistance
- 4.1.3 State Ohm's Law, Explain Its Importance, and Give an Application
- 4.1.4 Use Ohm's Law to Calculate Voltage, Current, and Resistance in a Series Circuit
- 4.1.5 State Kirchhoff's Voltage Law for a Series Circuit and Give an Application
- 4.1.6 Verification of Kirchhoff's Voltage Law

4.1.7 Define Power and Give Its Units of Measurement
4.1.8 State a Formula for Calculating the Total Power Used in an Electrical Circuit
4.1.9 Calculate the Total Power Used by a Series Circuit

Performance Standard 4.2: Investigate Power in Parallel Circuits

4.2.1 State Kirchhoff's Current Law and Give an Application
4.2.2 Calculate the Main Line Current in a Parallel Circuit
4.2.3 State a Formula for Calculating Total Parallel Resistance
4.2.4 Calculate the Total Parallel Resistance
4.2.5 Calculate the Total Power Used in a Parallel Circuit

Performance Standard 4.3: Investigate Circuits Protection Devices

4.3.1 Describe the Function of Two Types of Circuit Protection and Give an Application of Each
4.3.2 Describe the Operation of a Fuse and Give Its Schematic Symbol
4.3.3 Operate a Circuit Using a Fuse
4.3.4 Test and Replace a Fuse
4.3.5 Describe the Operation of Two Types of Circuit Breakers and Give Their Schematic Symbols
4.3.6 Operate a Circuit Using a Circuit Breaker
4.3.7 Test and Reset a Circuit Breaker

CONTENT STANDARD 5.0: INTRODUCTION TO ELECTRICAL CONTROL WIRING

Performance Standard 5.1: Demonstrate Electrical Print Reading Skills

5.1.1 Describe the function of an electrical print
5.1.2 Describe the Four Basic Parts of a Ladder Diagram (Power Supply, Input Devices, Output Devices, Conductors)
5.1.3 Explain the six rules for drawing a ladder diagram (label all components, number all conductors, number all rungs, only show control devices, place only one load per rung, and place output devices on right)
5.1.4 Describe the function of cross-reference symbols and notes on an electrical print
5.1.5 Describe how to interpret a Ladder Diagram

Performance Standard 5.2: Investigate Electrical Panels

5.2.1 Describe the function of an electrical panel
5.2.2 Describe how to arrange panel wiring to terminal blocks
5.2.3 Describe how to size and install electrical terminal blocks
5.2.4 Install a terminal block in an electrical panel

Performance Standard 5.3: Investigate the Fundamentals of Panel Wiring

5.3.1 Describe how to number wires on a ladder diagram
5.3.2 Label numbers on an electrical print
5.3.3 Describe how to determine the number of wires to run between panels
5.3.4 Determine the number of wires to run from a control panel to an operator station
5.3.5 Describe how to determine wire colors for control panel wiring
5.3.6 Determine the wire colors needed for an application

Performance Standard 5.4: Sizing Disconnects and Overcurrent Devices

5.4.1 Describe how to size overcurrent protection devices
5.4.2 Select a circuit protection device for an electrical control system
5.4.3 Describe how to install and test circuit protection devices
5.4.4 Install and test a circuit breaker in an electrical panel
5.4.5 Describe how to size a safety disconnect switch
5.4.6 Size a safety disconnect switch

CONTENT STANDARD 6.0: WIRING ELECTRICAL PANELS

Performance Standard 6.1: Demonstrate Grounding Control Systems

6.1.1 Describe the national electrical code (NEC) grounding requirements for electrical systems
6.1.2 Describe the parts of an electrical control system grounding circuit
6.1.3 Describe how to install an electrical grounding circuit
6.1.4 Install a grounding circuit for an electrical control system
6.1.5 Describe how to inspect and verify an electrical grounding circuit
6.1.6 Inspect and verify an installed grounding circuit

Performance Standard 6.2: Demonstrate Internal Panel Wiring

6.2.1 Describe the function of panel wireways
6.2.2 Describe how to determine wire lengths inside a panel
6.2.3 Describe two methods to connect wires to terminal screws
6.2.4 Describe how to terminate panel wires
6.2.5 Install wires in an electrical panel
6.2.6 Install an electric motor circuit using an electrical print

Performance Standard 6.3: Demonstrate Wiring Between Electrical Panels

- 6.3.1 Describe two methods used to identify wires connecting two panels
- 6.3.2 Describe how to hand-feed wires through conduit
- 6.3.3 Run wires between panels

Performance Standard 6.4: Demonstrate Wire Bundling

- 6.4.1 Describe three common methods of wire bundling
- 6.4.2 Bundle wires in an electrical panel
- 6.4.3 Describe how to secure wire bundles in an electrical panel
- 6.4.4 Secure wire bundles in an electrical panel

Performance Standard 6.5: Demonstrate Wiring of a Motor

- 6.5.1 Describe how to splice motor wires using ring lug connectors
- 6.5.2 Splice and tape motor leads using ring lug connectors
- 6.5.3 Describe how to connect a motor to a control panel
- 6.5.4 Verify the operation of an installed electrical system
- 6.5.5 Install an electrical system given an electrical print

CONTENT STANDARD 7.0: INTRODUCTION TO TRANSFORMERS

Performance Standard 7.1: Investigate Transformers

- 7.1.1 Describe the function of a transformer and give an application
- 7.1.2 Describe the operation of a transformer and give its schematic symbol
- 7.1.3 Connect and operate a transformer
- 7.1.4 Describe how to calculate the output voltage of a transformer
- 7.1.5 Calculate the secondary coil voltage of a transformer
- 7.1.6 Describe how to troubleshoot a transformer
- 7.1.7 Troubleshoot a transformer by measuring continuity

Performance Standard 7.2: Sizing Transformers

- 7.2.1 Describe how to size a transformer
- 7.2.2 Size a transformer
- 7.2.3 Describe a transformer's input and output power relationship and explain its importance
- 7.2.4 Describe how to calculate the current load of a transformer
- 7.2.5 Calculate the current load on a transformer

Performance Standard 7.3: Investigate Transformer Types

- 7.3.1 Describe the function of two basic categories of transformers
- 7.3.2 Describe the function of a control transformer
- 7.3.3 Design a control transformer circuit to provide a given output voltage
- 7.3.4 Describe the function of a tap on the secondary of a transformer and give an application

CONTENT STANDARD 8.0: INVESTIGATE ENERGY EFFICIENCY AND CONSERVATION

Performance Standard 8.1: Identify Efficiency Principles

8.1.1 Define efficiency, conservation, weatherization, and primary building systems (e.g., building shells, window ratings, insulation ratings)

Performance Standard 8.2: Examine Primary Building Systems

8.2.1 Describe common techniques for reducing building energy consumption (e.g., behavioral, equipment upgrades, control systems, and proper maintenance)

8.2.2 Formulate cost benefit analysis for common lighting and appliance improvements

8.2.3 Describe various water heating systems and conservation methods

8.2.4 Describe how the different components that make up the building shell can affect a home's energy usage

8.2.5 Examine the efficiency of a residential building shell (e.g., blower door, infra-red camera, etc.)

8.2.6 Explain common mechanical systems (e.g., HVACR, plumbing, electrical)

8.2.7 Calculate energy loss through a home energy audit

Performance Standard 8.3: Investigate Policy and Codes

8.3.1 Research types of codes required for building construction and renovation (e.g., IBC, NEC, IECC)

8.3.2 Examine national, state, and local energy and efficiency policies

8.3.3 Describe the role of Energy Star in efficiency and conservation

8.3.4 Summarize techniques for energy efficient construction

8.3.5 Explain the role of industry certifications for efficient buildings (e.g., LEED, BPI, Passivhaus, Green Globes, HERS, etc.)

CONTENT STANDARD 9.0: CONSTRUCT ENERGY POWER SYSTEMS

Performance Standard 9.1: Investigate Solar Power Systems

9.1.1 Evaluate the advantages and disadvantages of solar power technology

9.1.2 Identify solar thermal and photovoltaic (PV) applications

9.1.3 Identify solar power system components and their functions

9.1.4 Identify safety hazards associated with solar power systems

9.1.5 List system sizing considerations

9.1.6 Identify electrical, mechanical, and structural system design considerations

9.1.7 Describe the tasks required to complete a site analysis (e.g., field sketching, sun path, building orientation)

9.1.8 Identify the effects of the environment on systems output

9.1.9 Describe how to install a simple residential PV system

9.1.10 Explain how to assess system operation and efficiencies

9.1.11 Recognize the tasks required when performing maintenance and troubleshooting

9.1.12 Identify appropriate codes and standards concerning installation, operation, and maintenance of systems and equipment

9.1.13 Formulate a plan, considering realistic constraints, for the implementation of a solar power system

9.1.14 Design and construct a basic solar power system

9.1.15 Investigate new technologies in solar power systems

Performance Standard 9.2: Investigate Wind Power Systems

9.2.1 Evaluate the advantages and disadvantages of wind power technology (e.g., environmental, economic, political)

9.2.2 Identify the important events, people, and organizations in the history of wind power to date

9.2.3 Describe wind energy concepts and how the energy is captured

9.2.4 List system sizing considerations

9.2.5 Describe the tasks required to complete a site analysis (e.g., location, maps, monitoring analysis)

9.2.6 Identify the basic functions and classifications of wind turbines

9.2.7 Identify major horizontal-axis wind turbine (HAWT) components and their function

9.2.8 Describe the wind farm environment and characteristics of the wind energy maintenance technician

9.2.9 Formulate a plan, considering realistic constraints, for the implementation of a wind power system

9.2.10 Design and construct a basic wind power system

9.2.11 Investigate new technologies in wind power systems

Performance Standard 9.3: Investigate Geothermal Power Systems

9.3.1 Evaluate the advantages and disadvantages of geothermal power technology

9.3.2 Describe different ways in which geothermal energy can be used

9.3.3 Research the history of geothermal power systems

9.3.4 Diagram how a geothermal heat pump works

9.3.5 Differentiate between surface and sub-surface technology

9.3.6 Describe geothermal power systems processes

9.3.7 Identify the different types of geothermal plants (e.g., flash, dry, binary)

9.3.8 Diagram how a geothermal power plant works

9.3.9 Describe drilling requirements

9.3.10 Discuss how a conventional geothermal reservoir works

9.3.11 Research potential geothermal resource locations

9.3.12 Investigate new technologies and processes in geothermal power systems