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2013 Energy Technology

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Direct inquiries to

LeAnn G. Miller
Instructional Design Specialist
Research and Curriculum Unit
Mississippi State University
P.O. Drawer DX
Mississippi State, MS 39762
662.325.2510
E-mail: leann.miller@rcu.msstate.edu

Kendra L. Taylor
Program Coordinator
Office of Career and Technical Education
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
601.359.3461
E-mail: ktaylor@mde.k12.ms.us
662.253.0278

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Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

Betsey Smith, Curriculum Manager
Scott Kolle, Project Manager
Jolanda Harris, Educational Technologist
Kristen Dechert, Editor

The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Dr. Lynn House, Interim State Superintendent of Education
Dr. O. Wayne Gann, Chair
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Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Energy Technology *Curriculum Framework and Supporting Materials* are based on the following:

Energy Education and Industry Standards

The industry standards used for the Energy technology curriculum are comprised of standards taken from the Center for Energy and Workforce Development and developed by the Florida Energy Workforce consortium. These standards were developed to serve as a guide for what students should know or be able to do through a study of energy in grades 9–12 and 2-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the energy industry, secondary and postsecondary instructors, and university specialists. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed.

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved. States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from http://www.corestandards.org/.

National Educational Technology Standards for Students

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21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and Information and Communication Technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

There are several resources for Mississippi teachers.

My PLC: An online registration for all professional-development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Blackboard/PACE site: An online resource

Preparation for Academic and Career Education (PACE) sites have been created for Mississippi career and technical educators to have one central location for obtaining information regarding their teaching practice and classrooms. Each of the 16 career clusters has an individual site. Within the appropriate PACE site, a career pathway that is currently taught in Mississippi schools will be located, along with information from the Mississippi Department of Education (MDE) state curriculum coordinator, the MDE student organization coordinator, and the Research and Curriculum Unit (RCU) curriculum specialist. As information that is relevant to an educator's particular course is available, this information will be posted to the PACE site.

To log in to Blackboard:

1. Visit http://rcu.blackboard.com.
2. Log in with your first initial, last name, and last four (4) digits of your social security number (e.g., ddorroh3456).
3. Input the password: rcu.
4. Should you need additional instructions, please call 662.325.2510.

Energy Technology Executive Summary

Pathway Description

Energy Technology is a pathway to introduce the student to the broad field of energy and the critical need for a skilled energy workforce. The Energy Technology program will provide a broad understanding of the electric and natural gas utility industry and the energy generation, transmission, and distribution infrastructure. The course includes business models, regulations, types of energy and their conversion to useable energy, emerging technologies, and the connection to careers in the energy industry. Students in the pathway will participate in active learning exercises, including integral activities of the SkillsUSA organization and supervised experiences. Students who successfully complete the competencies in this pathway will possess fundamental knowledge and skills that can be used to secure entry-level employment or as a foundation for continuing their education. Industry standards are adapted from the Center for Energy Workforce Development.

Industry Certification

The Center for Energy and Workforce Development (CEWD) offers an Energy Industry Fundamental Certificate for students who make a passing score of 70% or higher on the Energy Industry Fundamentals Certificate Exam. Competencies and objectives in the Energy Foundations I and II courses are from the Energy Industry Fundamental Curriculum outlined by CEWD.

Assessment

Students will be assessed using the Center for Energy Workforce Development's Energy Industry Fundamentals Certificate Exam during the first year. The first-year test is based on content from the first-year Energy Technology curriculum material. The second-year's course

work will be assessed using a performance-based assessment.

Student Prerequisites

In order for students to be able to experience success in the Energy Technology program, the following student prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in math (last course taken, or the instructor can specify the math)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Teacher Licensure

The latest teacher licensure information can be found at http://www.mde.k12.ms.us/educator-licensure.

Professional Learning

If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional learning specialist.

Course Outlines

Option 1—Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. Energy Generation Technician—Course Code: 997305
2. Energy Foundations II—Course Code: 997303
3. Alternative Energy—Course Code: 997304
4. Energy Foundations I—Course Code: 997302

Course Description: Energy Foundations I
This course provides a broad understanding of the electric and natural gas utility industry and the energy generation, transmission, and distribution infrastructure, commonly called the "largest machine in the world," which forms the backbone for the industry. The course includes business models, regulations, types of energy and their conversion to useable energy, emerging technologies, and the connection to careers in the energy industry.

Course Description: Energy Foundations II
This is the second part of the course Energy Foundations I and is a continuation of the concepts described above.

Course Description: Energy: Alternative Forms
This course covers the production and distribution of electricity generated from biomass, biofuel, nuclear, wind, and solar energy sources. In addition, this course supports Tier 3 and Tier 4 of the Energy Competency Model as outlined by the Center for Energy Workforce Development and the Employment and Training Administration.
The model is available at http://www.cewd.org/Documents/EnergyCompModel.pdf

Course Description: Energy Generation Technician
This course is designed to develop competencies in the areas of energy history and the global impact of renewable and nonrenewable resources; career opportunities; scientific and research concepts; biological and physical science principles; environmental principles; and solar energy safety. Laboratory-based activities are an integral part of this course. The activities include the safe use and application of appropriate technology, scientific testing, and observation equipment.

Course Name Energy Foundations I**—Course Code:** 997302

Unit	Unit Name	Hours
1	Orientation and Ethics	14
2	Structure of Energy Industry	34
3	Compliance and Application Procedures	58
4	Electric Power Generation	34
Total		140

Course Name Energy Foundations II—**Course Code:** 997303

Unit Number	Unit Name	Hours
5	Electric Power Transmission	25
6	Electric Power Distribution	25
7	Careers in Energy	35
8	Energy Innovations	40
Total		125

Course Name Alternative Energy**—Course Code:** 997304

Unit Number	Unit Name	Hours
9	Importance of Alternative Energy	25
10	Biomass and Biofuel	25
11	Nuclear Power	25
12	Solar Power	25
13	Wind Power	25
Total		125

Course Name Energy Generation Technician**—Course Code:** 997305

Unit Number	Unit Name	Hours
14	Generation System	15
15	Equipment Operation, Maintenance and Repair	25
16	Quality Operations	20
17	Diagnostics and Production Processes	8
18	Health, Safety, and Environmental Management	8
19	Oral and Written Communication	30
20	Application of Scientific Method, Mathematical Operations	14
Total		120

Option 2—Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. Energy Technician I—Course Code: 997300
2. Energy Technician II—Course Code: 997301

Course Description: Energy Technician I
This course provides a broad understanding of the electric and natural gas utility industry and the energy generation, transmission, and distribution infrastructure, commonly called the "largest machine in the world," which forms the backbone for the industry. The course includes business models, regulations, types of energy and their conversion to useable energy, emerging technologies, and the connection to careers in the energy industry.

Course Description: Energy Technician II
This course covers the production and distribution of electricity generated from biomass, biofuel, nuclear, wind, and solar energy sources. In addition, this course supports Tier 3 and Tier 4 of the Energy Competency Model as outlined by the Center for Energy Workforce Development and the Employment and Training Administration. This course is designed to develop competencies in the areas of energy history and the global impact of renewable and nonrenewable resources; career opportunities; scientific and research concepts; biological and physical science principles; environmental principles; and solar energy safety. Laboratory-based activities are an integral part of this course. The activities include the safe use and application of appropriate technology, scientific testing, and observation equipment.

Course Name Energy Technician I**—Course Code:** 997300

Unit Number	Unit Name	Hours
1	Orientation and Ethics	14
2	Structure of Energy Industry	34
3	Compliance and Application Procedures	58
4	Electric Power Generation	34
5	Electric Power Transmission	25
6	Electric Power Distribution	25
7	Careers in Energy	35
8	Energy Innovations	40
Total		265

Course Name Energy Technician II**—Course Code:** 997301

Unit	Unit Name	Hours
9	Importance of Alternative Energy	25
10	Biomass and Biofuel	25
11	Nuclear Power	25
12	Solar Power	25
13	Wind Power	25
14	Generation System	15
15	Equipment Operation, Maintenance, and Repair	25
16	Quality Operations	20
17	Diagnostics and Production Processes	8
18	Health, Safety, and Environmental Management	8
19	Oral and Written Communication	30
20	Application of Scientific Method, Mathematical Operations	14
Total		245

Energy Technology Research Synopsis

Introduction

The STEM cluster covers the broad field of occupations related to science, engineering, technology, and math. This curriculum is designed to meet a nationwide demand for new workers in the energy utility industry. According to the Center for Energy Workforce Development (CEWD), the industry will experience a drastic increase in retirement eligibility over the next 5-10 years. More than half of the non-nuclear power plant operators, 52% of generation maintenance attendants, 40% of all transmission and distribution workers, and 46% of engineers will be eligible for retirement in 2012. This dramatic shift means there will be a great opportunity for new energy utility employees to join the workforce and to learn from experienced workers before they retire.

In Mississippi, there are approximately 535,000 employees in the Electric and Natural Gas Utility workforce. Although this number is low compared to other industries, this field is essential to ensuring the development and sustainability of all other industries (Center for Energy Workforce Development, 2011). Mississippi's role in the energy industry is growing consistently. Along with established companies, including Tennessee Valley Authority, Entergy, Mississippi Power, and 4 County Electric, new companies are on the rise. On September 16, 2012, Stion, a solar energy company, opened its doors in Hattiesburg, MS. KiOR, a facility that will produce environmentally friendly gasoline and diesel blendstocks, will have a fully operational plant in Columbus, MS, by the end of 2012. Another, larger facility will also break ground in Natchez, MS soon after the Columbus is fully operational. This statewide and national growth has created an open environment for new personnel to learn from and replace the

outgoing energy workers as well as helped blaze the trail for new industries breaking ground in Mississippi.

Needs of the Future Workforce

The 2011 Gaps in the Energy Workforce Pipeline survey took a longer look at potential replacements and forecast out in 5-year increments to the year 2020. Over the next decade, almost 62% of the industry has the potential to retire or leave for other reasons. For those positions considered critical by the industry, skilled utility technicians and engineers (excluding positions in nuclear), the analysis indicates that by 2014, 36% may need to be replaced due to potential retirement or attrition, with an additional 16% to be replaced by 2020—almost 110,000 employees in positions identified as the most critical by industry. Data for this synopsis were compiled from employment projections prepared by the CEWD.

	Potential Replacements 2010 - 2015		Potential Replacements 2015 - 2020	
Job Category	Potential Attrition & Retirement	Estimated Number of Replacements	Potential Retirement	Estimated Number of Replacements
Lineworkers	32%	22,100	15%	10,300
Technicians	39%	28,500	19%	13,500
Plant Operators	37%	12,400	17%	5,800
Engineers	38%	10,600	15%	4,100
Total	**36%**	**73,600**	**16%**	**33,700**
Totals exclude Nuclear				

Center for Energy and Workforce Development. (n.d.). Retrieved November 2, 2012, from http://www.cewd.org/surveyreport/CEWD-2011surveyreport-021512.pdf

Survey Methodology

The survey was an online tool sent to all CEWD, Edison Electric Institute, and American Gas Association members and asked them to provide data on actual and forecasted hires and attrition (both retirement and other attraction), age and years of service of the current workforce, number of employees in specific positions (lineworkers, electric and gas T & D technicians, non-nuclear generation operators, technicians, and engineers), and total number of employees. Additional

questions covered the status of Smart Grid implementation. The survey did not include data on nuclear positions. Shareholder-owned electric companies from across the country responded to the survey, as well as all electric co-cooperatives and some municipal utilities. The companies who responded to the survey collectively represent approximately 50% of the total electric and natural gas utility workforce.

Nuclear Energy

Nearly 38% of the nuclear industry work force will be eligible to retire within the next five years. To maintain the current workforce, the industry will need to hire approximately 25,000 more workers by 2015. This data is based on Nuclear Energy Institute's (NEI) 2010 Work Force Report.

In 2012, Grand Gulf Nuclear Station in Port Gibson, MS, will earn a new distinction in the global nuclear industry when an extended power uprate (EPU) makes it among the single most powerful nuclear generating unit of its type in the world. The upgrade will increase Grand Gulf's production by more than 13%, or approximately 178 MWe, bringing total (gross) output of the General Electric boiling water reactor to over 1,500 MWe. This information is from www.power-eng.com.

Perkins IV Requirements

The Energy Technology curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study, including secondary and postsecondary courses that will prepare them for occupations in these fields. Additionally, the Energy Technology curriculum is integrated with the Common Core State Standards. Lastly, the Energy Technology curriculum focuses on ongoing and meaningful professional development for teachers, as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Energy Technology curriculum are the Common Core State Standards for mathematics and science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the Common Core State Standards are designed to prep students for success in community colleges, institutions of higher learning, and careers.

Academic Infusion

The Energy Technology curriculum is tied to the National Common Core Framework for Language Arts and Mathematics standards. The curriculum provides multiple opportunities to enhance and reinforce these academic skills. Because students will be required to communicate effectively in the classroom as well as in the workforce, there is a considerable amount of writing in this curriculum. The academic content in the Energy Technology curriculum provides several

opportunities for focus in language arts, science, and mathematics as it directly related to Energy Technology content. Overall, the Energy Technology content requires students to preform calculations and to use strategic and critical thinking skills to solve real-world problems.

Transition to Postsecondary Education

The articulation plan is to be determined for the STEM career pathway.

Statewide Guidelines on Articulated Credit

Eligibility

- To be eligible for articulated credit, a student must do the following:
    - Complete the articulated secondary career and technical program
    - Score 70% or higher on the Energy Industry Fundamentals Certificate Exam in his or her secondary program of study
- To be awarded articulated credit, a student must do the following:
    - Complete application for articulated credit at the community or junior college
    - Enroll in the community or junior college within 18 months of graduation
    - Successfully complete 12 non-developmental career–technical or academic credit hours in the corresponding articulated postsecondary career–technical program of study

Transcripting of Articulated Credit

- Students must complete 12 non-developmental career–technical or academic credit hours in the articulated postsecondary career–technical program of study before the articulated credit is transcripted.
- No grade will be given on the transcript for articulated courses; only hours granted will be transcripted (thus resulting in no change in quality points).

Cost

- No costs will be assessed on hours earned through articulated credit.
- Articulation credit from secondary to postsecondary will be awarded upon implementation of this curriculum by the college. Courses to be articulated are yet to be determined at this time.

Best Practices

Experiential Learning (SAE)

The Experiential Learning (SAE) has long been and continues to be the backbone of every career and technical education (CTE) program. The experiential learning projects can be used in a variety of situations to reinforce and complement classroom theory and content. The experiential learning project consists of entrepreneurship, placement, research/experimentation, and exploration.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Energy Technology teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers and one teacher laptop. To make use of the latest online communication tools, such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning-management system, for example, the Agriculture Teacher Blackboard Content Management System, that introduces students to education in an online environment and places the responsibility of learning on the student.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. SkillsUSA is the student organization for Energy Technology. SkillsUSA provides students with growth opportunities and competitive events. It also opens the doors to the world of energy and scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Energy Technology curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and to solve problems without excessive conflict. The Energy Technology curriculum provides opportunities for students to work together and to help one another to complete complex tasks.

Conclusions

Energy Technology is a new curriculum and on the cutting edge of industry with high potential for growth in Mississippi and across the United States. Mississippi is one of the few states taking the lead in providing educational opportunities in the field of Energy. Students that complete these programs are well equipped for a variety of endeavors. Instructors are urged to encourage Energy Technology students to pursue educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

Center for Energy and Workforce Development. May be found at http://www.cewd.org
Phone: 202-638-5802
Fax: 202-508-5030
701 Pennsylvania Ave. N.W.
3rd floor
Washington, DC 20004-2696

Mississippi ACTE. May be found at http://www.mississippiacte.com/

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703.777.8810
http://www.skillsusa.org/

NCCER
3600 NW 43rd Street, Bldg. G
Gainesville, FL 32606
http://www.nccer.org/

Industry Support
Southern Power (Mississippi Power)
Entergy
Chevron

Using this Document and the Blackboard Site

Suggested Time on Task
An estimated number of clock hours of instruction that should be required to teach the competencies and Performance Indicators of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Suggested Teaching Strategies (Found on the Blackboard site)
This section of each unit indicates research-based strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies that reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.

Suggested Assessment Strategies (Found on the Blackboard site)
This section indicates research-based strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students
This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and objectives for the unit are also identified.

References
A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Orientation and Ethics

Competencies and Suggested Objectives
1. Describe employment opportunities and responsibilities for regional industries. DOK 2, EI 6.0, EI 9.0, ET 11.0 a. Describe employment opportunities in the energy industry. b. Describe education and experience requirements for employment in the energy industry. c. Describe earning and working conditions in the energy industry. d. Describe employability skills necessary for employment in the energy industry. e. Complete a job application. f. Complete a personal résumé. g. Conduct a job interview.
2. Describe local-program and vocational-center policies and procedures. (DOK 2) a. Describe local school rules found in the student handbook. b. Describe attendance policies. c. Describe laboratory and facilities associated with the program. d. Compare and contrast school and industry expectations.
3. Identify SkillsUSA activities pertaining to energy. (DOK 1, ET2.0) a. State procedures of leadership used in organizational meetings to reach an agreement in an orderly manner, including procedures for gaining recognition in a meeting and conducting a SkillsUSA meeting. b. Describe the purposes of SkillsUSA, including leadership development, personal development, and skills competition.

Unit 2: Structure of Energy Industry

Competencies and Suggested Objectives
1. Demonstrate knowledge of the basic and emerging principles and concepts that impact the energy industry. DOK 2, EI 1.0, ET 15.0 a. Explain the flow of energy from generation through distribution to the customer. b. Discuss the history of the U.S. energy industry/infrastructure. c. Identify the role and function of generation, transmission, and distribution organizations. d. Explain the role of regulatory bodies in the energy industry. e. Discuss environmental laws and regulations that impact the energy industry (local, state, and federal) and explain importance of proper documentation to ensure compliance. f. Explain the different structures of energy companies, including investor-owned utilities, municipalities (and associated utility practices, such as water/wastewater), electric cooperatives, and independent power producers. Also explain the different lines of energy business, including electric and gas. g. Describe the process of electric metering and billing for energy consumption. h. Discuss the importance and role of unions in the industry.

Scenario

Fireball

You have been hired as a technician for Mississippi Entel. You are to replace a propane tank on a generator at a remote tower. Upon entering the radio shack, you did not properly discharge accumulated static. When you reached down to disconnect the hose, a quantity of gas leaked out and ignited when your wrench touched the cylinder. The resulting fireball startled you, which caused you to fall backward and hit your head on a tool cabinet. Describe the proper steps that need to be taken to prevent this type of accident.

Attachments for Scenario

None

Unit 3: Compliance and Application Procedures

Competencies and Suggested Objectives

1. Evaluate and apply compliance with procedures necessary to ensure a safe and healthy work environment. DOK 4, EI 2.0, ET 10.0
   (Evaluation of a safe and healthy work environment will be conducted throughout the length of this course.)
   a. Discuss the role of the U.S. Department of Labor/Occupational Safety and Health Administration in work place safety.
   b. Identify both potential hazards and accident scenarios in the work environment.
   c. Follow established safety procedures (OSHA regulations and utility company procedures).
   d. Evaluate changes in the environment with respect to their impact on safety of self and others.
   e. Promote effective local, state, and national security operations for the protection of people, data, property, and institutions.
   f. Comply with energy-industry safety procedures and proper ways to perform work.
   g. Name potential threats created by deviation from safety procedures and improper use of tools and equipment.
   h. Use safety equipment as specified by user manuals and safety training.
   i. Use personal protective equipment, (PPE) including safety glasses, hearing protection, gloves, work boots, and hard hats.
   j. Keep personal safety equipment in good working order.
   k. Use tools and equipment in compliance with user manuals and training.
   l. Call attention to potential and actual hazardous conditions as they arise.
   m. Alert coworkers and supervisory personnel to hazardous conditions and deviations from safety procedures in a timely manner.
   n. Maintain appropriate certification and be knowledgeable in first aid or first-response procedures.
   o. Demonstrate understanding and knowledge of lock/tag-out practices in the workplace.
   p. Notify person in charge and/or coworkers of unsafe work conditions.
   q. Stop the job if there are unsafe working conditions.

Scenario

Service Truck Safety

A tornado has touched down in the city of Booneville. You must take a company service truck to check the security of a substation in the middle of Booneville. You and two other technicians pick up the keys from the dispatch and go to the parking lot where service trucks are kept. Write the procedures and precautions that must be accomplished prior to driving out of the parking lot.

Attachments for Scenario

None

Unit 4: Electric Power Generation

Competencies and Suggested Objectives

1. Understand electric power generation. DOK 3, EI 3.0,EI 11.0, AE 1.0, AE 2.0, AE 3.0, AE 4.0, AE 5.0
   a. Explain the conventional electric-power-generation systems and process (coal, gas, hydroelectric, and nuclear).
   b. Identify electric-power-generation equipment and systems.
   c. Identify various conventional electric-power-generation fuel sources and the cost/ efficiency/environmental issues associated with each:
   d. Identify various conventional electric power generation fuel sources and the cost/ efficiency/environmental issues associated with each:
      - Explain how oil was created and list its advantages and disadvantages.
      - Explain how coal was created and what are its advantages and disadvantages.
      - Explain how natural gas was created and what are its advantages and disadvantages.
      - Explain how water is used in hydroelectric power generation and what are its advantages and disadvantages.
      - Explain how uranium is created and what are its advantages and disadvantages.
   e. Discuss emerging and alternative electric power generation technologies and fuel sources.
   f. Explain how solar energy is used to produce electricity in photovoltaic systems and what are its advantages and disadvantages.
   g. Explain how solar energy is used to produce electric energy using steam and what are its advantages and disadvantages.
   h. Explain how wind energy is used to produce electric energy and what are its advantages and disadvantages.
   i. Explain how geothermal energy is used to produce electric energy and what are its advantages and disadvantages.
   j. Explain how biomass energy is used to produce electric energy and what are its advantages and disadvantages.
   k. Explain how ocean-wave energy is used to produce electric energy and what are its advantages and disadvantages.
   l. Discuss pros and cons of various energy producing technologies and fuels in the electrical infrastructure, including fossil, nuclear, and emerging alternative energy systems.

Scenario

It's Shocking!

(CEWD Module 3 Scenario)
Tim is an employee for PowerCor Industries. He is trying to repair a faulty electric three-phase motor circuit that seems to have a wiring-related problem. Tim was taught to always use his voltmeter first to make sure the power is off for safety reasons. Tim finds a circuit breaker panel that he thinks is the one for that particular motor and turns it to the OFF position. Tim connects his voltmeter leads to the wires in question and his meter displays 0 (zero) volts.

Zero is the number Tim anticipated, so he feels safe and confident in his measurement. He begins to work on the electrical equipment in front of him. Unfortunately for Tim, the power is still very much on and he is shocked with 277 volts of three-phase electricity. He is thrown back from the equipment onto the platform below. He does not die, but suffers serious burns to his right hand and will miss a lot of work while his injuries heal. Tim does not understand what went wrong or even why he got hurt.

- What step(s) in using a voltmeter as a safety tool did Tim skip when working around dangerous levels of high voltage electricity?
- What could he have done differently to prevent this injury from happening?
- How does working with high-voltage levels differ from working with low-voltage levels?
- Name the procedure for turning off a breaker.
- Could secondary gloves have prevented this accident?

Attachments for Scenario

None

Too Low!

Denario is an operator in the control room of a coal-fired power plant. While he is monitoring the control console, he notices a low pressure on a gauge. The pressure should be 950 psi +/– 50 psi but is only registering 800 psi. He leaves the control room to troubleshoot the drop in pressure. After approaching the area, he notices a loud hiss, which indicates a leak. He sees the insulation covering the pipe and begins to hover his bare hand around the pipe to locate the leak. As his hand approaches the leak, he receives third-degree burns to his palm. Address Denario's mistake by outlining the proper procedure when a leak is detected. What tools could be used to detect the source of a leak?

Attachments for Scenario
None

Unit 5: Electric Power Transmission

Competencies and Suggested Objectives
1. Understand electric-power transmission. DOK 1, ET 4.0 a. Explain the electric-power-transmission process. b. Discuss the application of different electric-power-transmission principles (including AC vs. DC). c. Name electric-power-transmission equipment and systems. d. Discuss the emerging technologies in electric-power transmission (including Smart Grid). e. Explain ownership/governance of the electric-transmission system.

Scenario

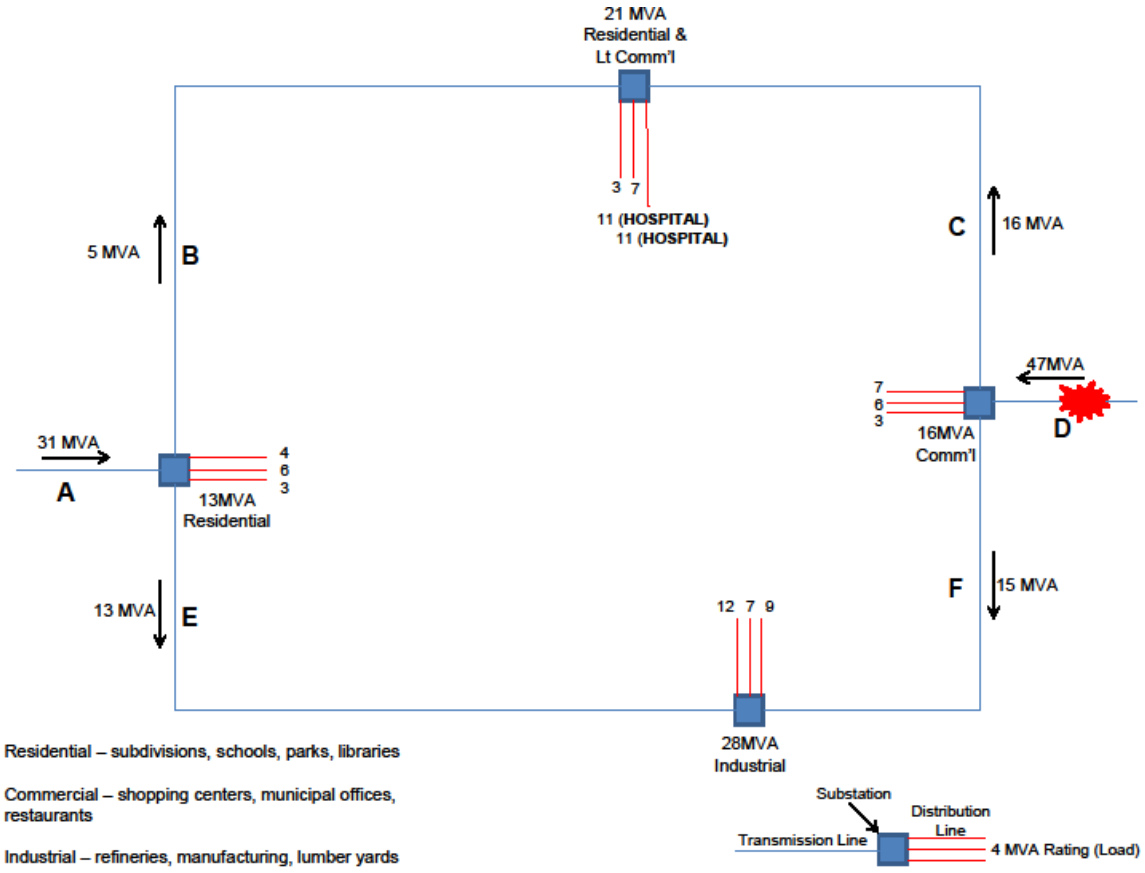
Tornado Tree Down

There are four substations in the city of Pascagoula. Each substation serves its respective quadrants (see diagram). Quadrants 3 and 4 are mainly residential whereas Quadrant 2 is industrial, and Quadrant 1 has two hospitals, one grade school, an assisted living facility with 100 beds, medical private practices, and two pharmacies.

A tree has fallen on the larger feeder transmission line. What should you do about supplying power to the town?

Attachments for Scenario

City Diagram



A. Normal power flows are shown for normally operating transmission system.
B. Tornado moves through town causing tree to fall on and open breaker protecting line D, which causes line D to be de-energized and power flow to be interrupted from line D.
C. If line A can only carry 65 MVA,
    1. What happens if no operational changes are made?
    2. What can be done operationally to limit flow on line A to 65 MVA?
    3. What are the consequences and/or advantages/disadvantages of the changes made in (2) above?

Unit 6: Electric Power Distribution

Competencies and Suggested Objectives
1. Understand electric-power distribution. DOK 2, ET 5.0 a. Explain the electric-power-distribution process. b. Discuss the need for electric-distribution systems and how they are designed to operate. c. Name electric-power-distribution-system equipment and what the various components do.

Scenario

Something Squirrely

(CEWD 5) Scenario – Electric Power Distribution
Bob is a serviceperson, who has received a call from the dispatcher that power is out at Montrose St. and 31st Ave. Upon arrival, he notices a squirrel lying on the ground near the pole. He calls dispatch and notifies them that he has found the problem (a squirrel shorted the switch). He exits the truck and puts on his PPE and takes out his extendostick. He now removes the fuse barrel from the switch; he retracts the extendo stick and re-fuses the barrel with the proper fuse. He runs (extends) the pole back up and installs the fuse. He is now ready to re-energize the switch. He calls the dispatcher to let him or her know he is ready to energize the line, and the dispatcher gives him the okay to energize. He closes the line, and the switch blows. What important steps did Bob leave out?

Attachments for Scenario

None

Unit 7: Careers in Energy

Competencies and Suggested Objectives

1. Identify and describe careers and entry requirements. DOK 1, EI 6.0, EI 9.0, ET 4.0
   a. Describe entry-level careers available in energy generation, transmission, distribution and the education/experience requirements for entry into those positions, along with career development and advancement opportunities from those positions.
   b. Identify entry-level careers available in business and corporate support functions of the energy industry; describes the education/experience requirements for entry into those positions, and career advancement opportunities from those positions.
   c. Describe general wage/salary, benefits, and other advantages of careers in the energy industry.
   d. Explain the educational pathways available to gain training necessary for entry into energy careers at secondary and postsecondary levels (Partner to create Energy Education Portal).

2. Describe the importance of professional ethics and legal responsibilities. DOK 3, EI 2.0, EI 13.0, ET 10.0, ET 15.0*
   a. Evaluate and justify decisions based on ethical reasoning.
   b. Evaluate alternative responses to workplace situations based on personal, professional, ethical, legal responsibilities, and employer policies.
   c. Identify and explain personal and long-term consequences of unethical or illegal behaviors in the workplace.
   d. Interpret and explain written organizational policies and procedures.

   *Competency 2 will be incorporated into the Energy Technology curriculum throughout all courses when appropriate.

3. Demonstrate leadership and teamwork skills needed to accomplish team goals and objectives. DOK 3, EI 8.0, EI 9.0, EI 13.0, ET 2.0, ET 15.0*
   a. Employ leadership skills to accomplish organizational goals and objectives.
   b. Establish and maintain effective working relationships with others in order to accomplish objectives and tasks.
   c. Conduct and participate in meetings to accomplish work tasks.
   d. Employ mentoring skills to inspire and teach others

   *Competency 3 will be incorporated into the Energy Technology curriculum throughout all courses when appropriate.

4. Demonstrate personal money-management concepts, procedures, and strategies. DOK 3, EI 13.0, ET 4.0, ET 14.0, ET 15.0*
   a. Identify and describe the services and legal responsibilities of financial institutions.
   b. Describe the effect of money management on personal and career goals.
   c. Develop a personal budget and financial goals.
   d. Complete financial instruments for making deposits and withdrawals.
   e. Maintain financial records.
   f. Read and reconcile financial statements.

g. Research, compare, and contrast investment opportunities.
*Competency 4 will be incorporated into the Energy Technology curriculum throughout all courses when appropriate.

5. Solve problems using critical-thinking skills, creativity, and innovation. DOK 3, ET 8.0, ET 10.0, ET 2.0, ET 11.0, ET 15.0
   a. Employ critical-thinking skills independently and in teams to solve problems and make decisions.
   b. Employ critical-thinking and interpersonal skills to resolve conflicts.
   c. Identify and document workplace performance goals and monitor progress toward those goals.
   d. Conduct technical research to gather information necessary for decision-making.

Scenario

Time to Travel

CEWD Module 6 Scenario

Ms. Brown and Mr. Smith are coworkers in an energy company. Their supervisor is Ms. Valerie Blackwell, and she has asked them to accompany her to a weekend seminar/workshop in Denver, CO. The trip will require them to stay over one night before and a night after the seminar/workshop.

Explain the travel arrangements and sleeping arrangements for these three people to attend this weekend seminar/workshop.

Attachments for Scenario

None

Unit 8: Energy Innovations

Competencies and Suggested Objectives
1. Evaluate and analyze energy topics and trends. DOK 3, EI 1.0, EI 7.0m EI 8.0, EI 9.0, EI 10.0, EI 11.0, EI 13.0, AE 1.0, AE 2.0, ET 2.0, ET 5.0, ET 15.0 a. Describe energy efficiency and conservation. b. Describe alternative energy (wind, solar, biomass, geothermal). c. Describe emerging technologies (wave, algae, IGCC, clean coal, etc.) d. Describe employability skills necessary for employment in the energy industry. e. Describe Smart Grid and Time of Use technologies f. Describe key energy regulatory topics (Cap and trade, etc.), efficiency, cost, and so forth.
2. Understand natural gas transmission and distribution. DOK 2, EI 11.0, AE 1.0 a. Explain the fundamental concepts of natural gas. b. Identify the components and workings of the gas transmission and distribution network, including metering and regulating stations.

Scenario

Don't Let It Leak

CEWD 7

LeAnn is working in maintenance and has received a work order to install a new natural gas line. She goes to the supply depot and receives all of her materials. She and her assistant installed a new line according to the work order. The next day a coworker smells gas in the area of the new installation and suspects there is a leak in the newly installed plumbing. The maintenance crew is called back and verifies that a leak is present. What is the most likely problem with this new installation?

Attachments for Scenario

None

Unit 9: Importance of Alternative Energy

Competencies and Suggested Objectives
1. Discuss the value of alternative energy. DOK 3, EI 1.0, EI 11.0, EI 12.0, AE 1.0, AE 2.0, AE 3.0, AE 4.0, AE 5.0, ET 3.0 a. Investigate the reasons for seeking alternatives to fossil fuels. b. Summarize the contributions to world energy supplies of conventional alternatives to fossil fuels. c. Discuss the three alternative energy sources that are currently the most developed and widely used (hydroelectric, nuclear, and biomass).

Scenario

The Proposal

You are a member of a startup company that has developed a new alternative energy system, which combines a biomass system with a solar water heater. Your company will propose a new international business to potential investors. Prepare a written proposal (minimum four pages) for the venture, describing the type of business, proposed country for trade (hint: tropical island nations), rationale for selecting the country (hint: current high cost of energy, all diesel is currently imported, municipal waste and animal waste disposal issues, abundant sunshine) identifications of existing trade barriers, and a thorough analysis of the international business situation (economic and political systems, culture, and trade area). The proposal must describe the planned business operation (organization, product/services, and strategies) as well as planned financing (hint: USAID, EXIM Bank), including income and expenses.

In addition to the written proposal, give an 8-10 min presentation about the proposal, selling the idea to potential investors.

Attachments for Scenario

None

Unit 10: Biomass and Biofuel

Competencies and Suggested Objectives
1. Investigate the viability of biomass and biofuel. DOK 2, EI 1.0, EI 7.0, EI 11.0, EI 12.0, AE 1.0, AE 2.0 a. Discuss the major sources of biomass. b. Define biofuels (e.g., ethanol, biodiesel, and methanol). c. Outline the pyramid energy flow, including the different trophic levels. d. Describe the major sources, scale, and impacts of biomass energy. e. Draw and label a diagram of biomass plantations. f. List the advantages and disadvantages of using biomass for energy (e.g., CO2 emissions, photosynthetic efficiency, cost, etc.) producers and explain the different lines of energy business, including electric and gas.

Scenario

Time and Temperature

Compare energy content of different biomass feedstocks – measure heat output in Joules or BTU/pound.

Materials needed
1 kg wood chips (fresh wood chopped up)
1 kg saw dust
1 kg pine cones
1 kg hay – compacted
1 kg coal (if available)
Starter logs of uniform size to start combustion of each type of fuel – cubed in 1x1-in. pieces
Small grill with a cover (such as a small Brinkman or Thermos brand) to use as the combustion chamber – line grill bottom with heavy duty aluminum foil to prevent any material from falling out the bottom vents
Infrared thermometer

Directions
Place biomass in the grill and start fire using the starter log (use same-size, small pieces of 1-in. x 1-in.)
Use infrared thermometer to monitor grill cover in 1-min intervals until you start to see the cover temperature start to drop.
Plot the temperature on a time scale – compare the maximum of each graph and the length of time the fire lasted for each fuel.

Attachments for Scenario

None

Unit 11: Nuclear Power

Competencies and Suggested Objectives
1. Investigate the use of nuclear power. DOK 2, EI 1.0, EI 7.0, EI 11.0, AE 1.0, AE 3.0, ET 1.0 a. Explain the process of nuclear fission. b. Define radio-isotopes and half-life. c. Evaluate the advantages and disadvantages of nuclear power. d. Draw and label a diagram of a Light-Water Reactor (LWR) (e.g., control rods, coolant, containment vessel, dry casks, turbine, etc.). e. Describe nuclear energy and how it is harnessed. f. Describe the Chernobyl Nuclear Power Plant accident. g. Outline the societal debate over nuclear power.

Scenario

An Ounce of Prevention

James is an operator in a nuclear power plant. While monitoring the console he notices the pressure rising on the steam line going to the turbine. Further investigation reveals the flow rate for the condenser cooling water is lower than it should be. James reviews maintenance records and finds that a scheduled PM (Preventive Maintenance) was missed. What needs to be done in order to find the fault?

Attachments for scenario:

None

Unit 12: Solar Power

Competencies and Suggested Objectives
1. Investigate the viability of solar power. DOK 3, EI 1.0, EI 7.0, EI 11.0, AE 1.0, AE 4.0, ET 3.0 a. Describe solar energy and how it is harnessed. b. Explain the significance and historical foundations of solar energy and its pioneers (Horace de Saussure and Clarence Kemp). c. Explain the difference between passive solar and active solar. d. Draw and label a diagram of PV cells (e.g., array, panel, module, boron-enriched silicon). e. Describe a central receiver system. f. Draw and label a diagram of a solar thermal plant. g. Evaluate the advantages and disadvantages of using solar energy.

Scenario

Solar Thermal Systems

Materials needed
1-in.-diameter black PVC pipe sections – 4 x 2-ft sections
3 x U connectors (black)
2 x 90º ends (black)
1 plastic cap (black)
1 valve (threaded)
1-in.-diameter white PVC pipe sections – 4 x 2-ft sections
3 x U connectors (white)
2 x 90º ends (white)
1 plastic cap (white)
1 valve (threaded)
PVC glue for connectors
Thermometer to measure water temperature
Utensil (plastic jug) to pour water from and collect water in

Directions
Compare the temperature of water coming out of black PVC pipe system that you build to a system of white PVC pipes. These "devices" are exposed to the sun on the same day for the same period of time, and you pour the same amount of water in each device. Make sure you measure the water temperature before pouring it in.

Try the same experiment with a different fluid such as anti-freeze.

Unit 13: Wind Power

Competencies and Suggested Objectives
1. Investigate the viability of wind energy. DOK 3, EI 1.0, EI 7.0, AE 1.0, AE 5.0, ET 15.0 a. Describe nuclear energy and how it is harnessed. b. Explain the significance of wind energy and its pioneers (Charles Brush). c. Define *kinetic energy*. d. List and describe the topography and weather patterns of the states that are considered the "Saudi Arabia of wind power." e. Explain the acronym NIMBY (Not In My Backyard). f. Explain why farmers and ranchers are amenable to wind technology. g. Evaluate the advantages and disadvantages of wind technology.

Scenario

Keep It In Proportion

Plot the relative scales of different-size wind turbines – build scale models of wind turbines at 50KW, 850KW, 1.5MW, 2MW, 5MW, and 7MW and include a Boeing 747 airplane (use a 1:200 or 1:250 scale replica that is available commercially) as the reference point.

Measure the height of the school building to see how tall the tower is on a 5MW wind turbine and the size of the wing span or measure out the distance from top to the bottom of the pole and include the length of the pole that is underground. Have one student stand on each end of the tower/pole length to get a sense of how tall these structures are. How many school buses lined up end to end make up the length a single blade of the 5MW turbine (and the rotor diameter)?

Attachments for scenario:

None

Unit 14: Generation System

Competencies and Suggested Objectives
1. Understand generation system overview. DOK 2, EI 1.0, EI 3.0, EI 4.0, EI 5.0, EI 6.0, ET 6.0, ET 7.0 a. Explain and use the fundamental laws and principles of electricity and magnetism (e.g., electric charge, electric current, etc.). b. Explain the components of electrical generating systems including boilers, generators, alternators, turbines, motors, engines, pumps, and switchgear. c. Explain the differences and similarities of power generation, including use of different fuel types and different power plant uses (i.e., base load, peaking, load following, and co-generation). d. Explain the basic operating principles of fossil, hydroelectric, internal combustion, and nuclear reactor systems, which supply the bulk of the North American power grid. e. Discuss the electric-power-generation job functions.

Scenario

Not Enough Power

You are working as a technician for Dubose Electric. Your company is responsible for maintaining all substations for Pantherville and Gator City. One of the substations that distributes electric power to the consolidated correctional facility is supplying only 100 V.

What are some possible causes for this abnormal condition?

What are some possible remedies for this abnormal condition?

Attachments for scenario

None

Unit 15: Equipment Operation, Manitenance, and Repair

Competencies and Suggested Objectives
1. Apply equipment operation, maintenance, and repair. DOK 3, EI 2.0, EI 10.0, ET 7.0, ET 8.0, ET 9.0, ET 10.0, ET 13.0, ET 14.0 a. Comply with procedures necessary to ensure a safe and healthy work environment. b. Operate, repair, and test machines, devices, and equipment based on electrical or mechanical standards. c. Exhibit an understanding of equipment principles to be able to diagnose and repair machine malfunctions. d. Operate basic hand and small electric tools and electronic test equipment. e. Perform tests and inspections of products, services or processes to evaluate quality or performance. f. Determine the correct kind of tools and equipment needed to do a job. g. Read gauges dials or other indicators to make sure a machine is working properly. h. Read, interpret, and create basic prints used in the design, operation, and maintenance of electrical and mechanical equipment, including engineering drawings, diagrams and schematics, documentation diagrams, and single line diagrams.

Scenario

Getting Dull

Carl is an apprentice lineworker who is framing (installation of hardware for the pole), an 8 kV pole. After climbing the pole, his first job is to drill four holes in the pole with a cordless drill. After repeated attempts of drilling the first hole, the bit becomes dull. What is the most likely problem Carl is having?

Attachments for Scenario

None

Unit16: Quality Operations

Competencies and Suggested Objectives
1. Demonstrate the ability to design, analyze, and effectively use systems, components, and methods with a framework of quality and continuous improvement. DOK 4, EI 8.0, EI 10.0, AE 1.0, ET 2.0, ET 7.0, ET 10.0, ET 13.0, ET 15.0 a. Conduct tests and inspections of products, services, or processes to evaluate quality or performance. b. Incorporate new information into both current and future problem solving and decision making. c. Monitor/assess performance of self and other individuals or organizations to make improvements or take necessary corrective action. d. Describe how a system should work and how changes in conditions, operations, and the environment will affect the performance of that system. e. Use logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems. f. Identify the value of preventative/predictive maintenance versus reactive maintenance.

Scenario

Getting Lazy

A breaker protects a distribution feeder serving over 700 residential and commercial customers in a community. Although PowerProvider, Inc. has standards to conduct periodic preventative maintenance on their equipment, a less-than-motivated employee decided to skip the 1-hr maintenance procedure on a particular breaker on Friday afternoon. What are the possible consequences of his neglecting his job duties?

Attachments for scenario:

None

Unit 17: Diagnostics and Production Processes

Competencies and Suggested Objectives
1. Diagnose and correct abnormalities and malfunctions in equipment and production processes. DOK 3, ET 7.0, ET 9.0, ET 11.0, ET 15.0 a. Demonstrate knowledge of normal equipment operation (how individual pieces of equipment relate to each other) in order to anticipate potential equipment problems before they occur. b. Determine causes of operating errors and recommend appropriate course of action. c. Describe when and how to notify supervisory personnel in the event of operational errors or equipment malfunctions.

Scenario

Spinning Out of Control

You are proceeding to drill a quarter-inch hole in a four-square metal plate. While drilling, you smell and see smoke emanating from both metal plate and the drill motor. You apply more pressure, and the metal plate begins to spin.

What are the possible causes or operating errors that could have caused the actions within the scenario, and what would you recommend as the appropriate course of action?

Attachments for scenario:

None

Unit 18: Health, Safety, and Environmental Management

Competencies and Suggested Objectives
1. Demonstrate the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance. OK 2, EI 2.0, ET 10.0, ET 11.0, ET 15.0 a. Describe personal and jobsite safety rules and regulations that maintain safe and healthy work environments. b. Explain emergency procedures to follow in response to workplace accidents. c. Create a disaster- and/or emergency-response plan.

Scenario

Leaning Ladder

Samantha is a technician in a power plant. She is replacing a fire sensor in the ceiling of the control room. She has an A-frame ladder leaning against the wall because there was a cabinet in the way. While she is on the ladder and removing the faulty sensor, the ladder slides out and she falls to the floor. Her head strikes the wall on her way down, and she is bleeding from her forehead. Jan finds Samantha lying on the floor holding her head. What procedures should Jan follow?

Attachments for scenario:

None

Unit 19: Oral and Written Communication

Competencies and Suggested Objectives
1. Use oral and written communication skills in creating, expressing, and interpreting information and ideas. DOK 4, EI 10.0, ET 8.0, ET 11.0, ET 12.0, ET 13.0, ET 14.0, ET 15.0 (Will create an in-depth presentation that encompasses all objectives over a given time period.) a. Select and employ appropriate communication concepts and strategies to enhance oral and written communication in the workplace. b. Locate, organize, and reference written information from various sources. c. Design, develop, and deliver formal and informal presentations using appropriate media to engage and inform diverse audiences. d. Interpret verbal and nonverbal cues/behaviors that enhance communication. e. Apply active listening skills to obtain and clarify information. f. Develop and interpret tables and charts to support written and oral communications. g. Exhibit public-relations skills that aid in achieving customer satisfaction.

Unit 20: Application of Scientific Method, Mathematical Operations

Competencies and Suggested Objectives

1. Demonstrate science knowledge and skills. DOK 3, EI 10.0, ET 11.0, ET 13.0, ET 14.0, ET 15.0
   a. Discuss the role of creativity in constructing scientific questions, methods, and explanations.
   b. Formulate scientifically investigable questions, construct investigations, collect and evaluate data, and develop scientific recommendations based on findings.
2. Demonstrate mathematics knowledge and skills. (DOK 2, Industry Standard Abbreviation)
   a. Demonstrate knowledge of the four basic operations (addition, subtraction, multiplication, division); geometric principles, including the Pythagorean Theorem; and simple algebraic functions.
   b. Analyze and apply data and measurements to solve problems and interpret documents.
   c. Construct charts/tables/graphs using functions and data.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation and Ethics		
	1.	Describe employment opportunities and responsibilities for regional industries.
	2.	Describe local-program and vocational-center policies and procedures.
	3.	Identify SkillsUSA activities pertaining to energy.
Unit 2: Structure of Energy Industry		
	1.	Demonstrate knowledge of the basic and emerging principles and concepts that impact the energy industry.
Unit 3: Compliance and Application Procedures		
	1.	Evaluate and apply compliance with procedures necessary to ensure a safe and healthy work environment.
Unit 4: Electric Power Generation		
	1.	Understand electric-power generation.
Unit 5: Electric Power Transmission		
	1.	Understand electric-power transmission.
Unit 6: Electric Power Distribution		
	1.	Understand electric-power distribution.
Unit 7: Careers in Energy		
	1.	Identify and describe careers and entry requirements.
	2.	Describe the importance of professional ethics and legal responsibilities.
	3.	Demonstrate leadership and teamwork skills needed to accomplish team goals and objectives.
	4.	Demonstrate personal money-management concepts, procedures, and strategies.
	5.	Solve problems using critical-thinking skills, creativity, and innovation.
Unit 8: Energy Innovation		
	1.	Evaluate and analyze energy topics and trends.
	2.	Understand natural gas transmission and distribution.

Unit 9: Importance of Alternative Energy		
	1.	Discuss the value of alternative energy.
Unit 10: Biomass and Biofuel Viability		
	1.	Investigate the viability of biomass and biofuel.
Unit 11: Nuclear Power		
	1.	Investigate the use of nuclear power.
Unit 12: Solar Power		
	1.	Investigate the viability of solar power.
Unit 13: Wind Power		
	1.	Investigate the viability of wind energy.
Unit 14: Generation System		
	1.	Understand generation-system overview.
Unit 15: Equipment Operation, Maintenance and Repair		
	1.	Apply equipment operation, maintenance, and repair.
Unit 16: Quality Operations		
	1.	Demonstrate the ability to design, analyze, and effectively use systems, components, and methods with a framework of quality and continuous improvement.
Unit 17: Diagnostics and Production Processes		
	1.	Diagnose and correct abnormalities and malfunctions in equipment and production processes.
Unit 18: Health, Safety, and Environmental Management		
	1.	Demonstrate the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance.
Unit 19: Oral and Written Communication		
	1.	Use oral- and written-communication skills in creating, expressing, and interpreting information and ideas.
Unit 20: Application of Scientific Method, Mathematical Operations		
	1.	Demonstrate science knowledge and skills.
	2.	Demonstrate mathematics knowledge and skills.

Appendix A: Unit References

The suggested resources for the Energy Technology units are listed below:

Units 1–Unit 6

Center for Energy and Workforce Development. (2011). *Energy industry fundamentals.* Mountain View Califormia: CORD.

Units 7–Unit 8

Center for Energy and Workforce Development. (n.d.). Retrieved November 2, 2012, from http://www.cordonline.net/cewd/module6section1.php

Center for Energy and Workforce Development. (n.d.). Retrieved November 2, 2012, from http://www.cordonline.net/cewd/module7section1.php

Units 9–Unit 20

National Center for Construction Education and Research. (2009). *Core curriculum: Introductory craft skills.* Boston, MA: Prentice Hall.

National Center for Construction Education and Research. (2010). *Introduction to the power industry*. Boston, MA: Prentice Hall.

National Center for Construction Education and Research. (2011). *Alternative energy*. Upper Saddle River , NJ: Pearson Eductation.

Appendix B: Glossary

Unit 1 – Orientation and Ethics

Honesty: Be honest and truthful in all dealings. Conduct business according to the highest professional standards. Faithfully fulfill all contracts and commitments. Do not deliberately mislead or deceive others.
Integrity: Demonstrate person integrity and the courage of your convictions by doing what is right even where there is pressure to do otherwise. Do not sacrifice your principles because it seems easier.
Fairness: Be fair and just in all dealings. Do not take undue advantage of another's mistakes or difficulties. Fair people are open-minded and committed to justice, equal treatment of individuals, and tolerance for and acceptance of diversity.
Leadership: By your own conduct, seek to be a positive role model for others.

Unit 2 – Structure of Energy Industry

Alternating Current (AC): an electric current that reverses its direction at regularly recurring intervals
Balancing authority: a regional organization responsible for planning for and maintaining the balance of electricity resources and electricity demand.
Blackout: power loss affecting many consumers over a large geographical area for a significant period of time
Clayton Antitrust Act of 1914: building on the Sherman Antitrust ACT, this law allows the Federal Trade Commission and Department of Justice to approve all proposed mergers
Clean Air Act of 1970 and Clean Air Act of 1990: laws that defines EPA's responsibilities for protective
Cogeneration: process in which electricity and heat are produced at the same time from the same fuel or energy source
Conductor: a material along which electrons easily flow; the opposite of a conductor is an insulator
Current: a flow of electrons along a path, such as a conductive wire
Direct Current (DC) – current that moves in only one direction; DC results from a constant polarity power source
Economies of scale: when cost of production falls because output has increased
Effluent: substance released into a body of water
Electrical power grid: interconnected electric generation, transmission, and distribution systems over broad geographic areas—Eastern, Western, and Texas
Electron: negatively charged particle outside the nucleus of an atom
Electrostatic precipitator: a device for removing small particles (such as smoke, dust, or oil) from a gas, such as air, by passing the gas first through an electrically charged screen that gives a charge to the particles, then between two charged plates where the particles are attracted to one surface
Emissions: substances released into the environment; usually used to refer to substances discharged into the air
Energy Policy Act of 1992: marked the beginning of competition in the electric power industry

Energy Policy Act of 2005: gave NERC enforcement power for reliability standards
Environmental Protection Agency (EPA):
agency tasked with enforcing laws protecting human health and the environment
Federal Energy Regulatory Commission (FERC): independent regulatory agency within the Department of Energy and the successor to the Federal Power Commission; it governs interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certifications
Federal Power Act 1928: provided funding for the Federal Power Commission, a five:person bipartisan committee given the power to regulate the sale and distribution of electricity
Federal Power Commission of 1920: created to coordinate hydroelectric projects under federal control
Federal Trade Commission (FTC): created in 1914 to enforce laws against monopolies; has since evolved into the agency that also administers consumer protection laws
Greenhouse Gas: gases that trap heat in the atmosphere such as carbon dioxide, methane, nitrous oxide and hydro fluorocarbons
Holding Company: a company which owns or holds stock in other companies, which it then manages and operates
Hydroelectric Power: power generated by using moving water to power a turbine generator to produce electricity
Load: device or customer that receives power from the electric system. Load should not be confused with demand, this is the measure of power that a load receives or requires
Load Diversity: when the peak demands of a variety of electric customers occur at different times
Natural Gas Act of 1938: legislation restricting the prices gas utilities could charge consumers
Natural Monopoly: a situation in which smaller companies is not able to compete with big companies in a particular industry sector and as a result a large company dominates the market; this results from the large company benefiting from economies of scale (meaning that the bigger company is able to operate more efficiently and offer services more cheaply to the consumer) and/or requires huge capital investments for equipment (meaning that no other companies want to spend the money needed to compete in the market)
North American Electric Reliability Corporation (NERC):
formed in 1968 in response to the 1965 blackout, NERC is the electric reliability organization cer tified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulkpower system. All bulk power system owners, operators, and users are required to register with NERC .
Nuclear Regulatory Commission (NRC): regulates nuclear power plants and other uses of nuclear materials, such as nuclear medicine, while protecting humans and the environment
Obligation to serve: the obligation of a utility to provide electric service to any customer who seeks that service, and is willing to pay the rates set for that service; traditionally, utilities have assumed the obligation to serve in return for an exclusive monopoly franchise
Peak load: time of highest demand for and use of electricity
Polarity: the orientation of the positive and negative poles of a power source
Pollution: the introduction of harmful contaminants into the environment
Public utility: maintains the infrastructure for providing a public service such as gas, electric, water and waste**:** disposal service
Public Utilities Regulatory Policies Act of 1978 (PURPA): a law passed promoting more

efficient use of fossil fuels and greater use of renewable energy for generating electricity.
Public Utility Holding Company Act of 1935 (PUHCA):
law that severely limited acquisition of any wholesale or retail electric business through a holding company and restricted ownership of an electric business by non-utility corporations
Reliability: the power system is able to meet the electricity needs of customers even when equipment fails or other factors reduce the amount of available electricity; consists of the adequacy and security of the electricity supply to consumers
Securities and Exchange Commission (SEC): agency created by Congress in 1933; regulates interstate transactions in corporate securities and stock exchanges
Sherman Antitrust Act of 1890: outlawed monopolies in the United States
Smart grid: modernization of the current grid technology; has the ability to monitor energy Flow and communicate data back to utility companies; uses smart meters; takes advantage Of distributed generation allowing smaller power sources to feed energy back into the grid; Stores energy generated in off-peak hours and distributes it during peak hours
Static electricity: an electrical charge that cannot move, created when two objects have been In contact and then are separated—leaving them with either too many or too few electrons (an electric charge)
Stepped down: conversion of high voltage electricity to lower voltage through the use of Transformers at power substations
Stepped up: conversion of low voltage electricity to higher voltage through the use of Transformers; a step-up transmission substation receives electric power from a nearby Generating facility and uses a large power transformer to increase the voltage for Transmission to distant locations
Transformer: a device that changes the voltage of an electric current
Wet scrubbers: installed on smokestacks to remove sulfur dioxides and some particulates by allowing exhaust gases to pass through a fine water spray that contains lime, a compound which absorbs most of the sulfur

Unit 2 Part II

Balancing authority: a regional organization responsible for planning and maintaining the balance of electricity resources and electricity demand
Blackout: power loss affecting many consumers over a large geographical area for a significant period of time
Cogeneration: process in which electricity and heat are produced at the same time from the same fuel or energy source
Cooperative energy utilities: nonprofit utility entities that are owned by the customers who are supplied with the services
Electric cooperatives: commonly known as co-ops; nonprofit utility entities that are owned by the customers who are supplied with the services; originally created and financed by low-cost federal government loans to ensure the supply of electric service to rural areas
Electric power distribution: the transfer of high voltage electrical energy from substations to the end customer
Electric power generation: process of creating electrical energy from other forms of energy
Electrical power grid: interconnected electric generation, transmission, and distribution Systems over broad geographic areas

Electric power transmission: the bulk transfer of high-voltage electrical energy from its source at generating plants to substations

Federal energy regulatory commission (FERC): an independent regulatory agency within the department of energy and the successor to the federal power commission; FERC governs interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas Pricing, oil pipeline rates, and gas pipeline certification

Fossil fuels: carbon-rich energy sources such as petroleum, coal, or natural gas, which is Derived from the decomposition of ancient (fossilized) living matter

Government-owned utilities: these include entities such as local authorities, local agencies, and county governing powers. Profits from government-owned utilities are used to pay for operating costs such as interest on loans, taxes, labor, and other human resources

Hydroelectric power: power generated by using moving water to power a turbine generator to Produce electricity

Independent power producer (IPP): also known as a non-utility generator (NUG); an entity Which is not a public utility, but which owns facilities to generate electric power to sell, Usually to public utilities

Independent system operator (ISO): created under the authority of FERC; designed to Administer the transmission grid on a regional basis in a neutral manner

Investor-owned utilities (IOU): utility entities that are privately owned by individual investors, Private funds, and private pension plans that purchase shares or stocks for the purpose of Receiving a financial return on investment

Merchant generators: businesses that have been formed to own power plants and market Their output; a merchant plant is one that has been built without a specific end user Selected, which allows the plant to be more competitive in the wholesale energy market

Municipal utilities (muni): nonprofit entities that are publicly-owned and controlled by local government agencies; municipal utilities may include the following services: natural gas, water, sewage, and telecommunications

North American Electric Reliability Corporation (NERC): formed in 1968 in response to the 1965 blackout, NERC is the electric reliability organization certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk-power system; all bulk power system owners, operators, and users are required to register with NERC.

Public utility: maintains the infrastructure for providing a public service such as gas, electric, water and waste- disposal service

Regional transmission organization (RTO): created under the authority of FERC; designed to administer the transmission grid on a regional basis in a neutral manner. FERC stated that entities desiring to be qualified as RTOs must first meet a specific list of characteristics and functions

Small power producer: small power plants that generate power to resell to others through renewable technologies such as biomass, geothermal, wind, and solar

Stepped down: conversion of high- voltage electricity to lower voltage through the use of transformers at power substations

Stepped up: conversion of low-voltage electricity to higher voltage through the use of transformers; a step-up transmission substation receives electric power from a nearby generating facility and uses a large power transformer to increase the voltage for transmission to distant locations

Transformer: a device that changes the voltage of an electric current
vertically integrated—a business structure in which the same company owns several or all levels of the production processes for a product or services

Unit 2 Part III

Boiler: a device for generating steam for power; heat from an external combustion source is transmitted to water contained within the waterwall tubes that line the furnace walls
Conductor: materials such as copper and aluminum that allow electrical current to flow freely through them
Current: a flow of electrons along a path, such as a conductive wire
Distribution system: the portion of electric system that is dedicated to delivering electric energy to an end user
Delta: a method of wiring for a three-phase connection in which three windings of a transformer or generator are connected end to end; when drawn in a line diagram, the shape resembles the Greek letter "delta" (δ)
Energy: the capacity to do work
Electrical energy: potential energy and kinetic energy associated with the position or movement of electrical charge
Electrical power grid (the "grid"): interconnected electric generation, transmission, distribution systems over broad geographic areas
Furnace: the portion of the generating unit containing the fire and fuel-burning equipment; the site where the chemical energy of the fuel is converted to thermal energy
Generator: the portion of the generating unit where the rotating mechanical energy is converted to electrical energy; it consists of a stator containing the armature windings and a rotor (center shaft) that is turned by the turbine to produce the magnetic field
Hydrocarbons: simple compounds containing only the elements hydrogen and carbon; fossil fuels are made of hydrocarbons
Kilowatt hours: the unit which expresses how much electrical energy a consumer uses
Step-down transformer: a transformer that has more turns in the primary winding than in the secondary winding; voltages are higher in the primary circuit than in the secondary circuit; used to lower voltage
Step-up transformer: a transformer that has fewer turns in the primary winding than in the secondary winding; the voltage in the primary circuit will be less than in the secondary circuit; used to increase voltage
Substation: a location along a transmission or distribution route containing equipment to transform and route power
Switchyard—the area at the generating station, that steps up voltages from the generator and routes it to the transmission lines
System load: the amount of electric power required by consumers
Transformer: a device that transfers power from one circuit to another; step-up transformers increase voltage from the primary to the secondary circuit while lowering current proportionally, while step-down transformers lower voltage from the primary to the secondary circuit while raising current proportionally
Transmission system: an interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points

at which it is transformed for delivery over the distribution system lines to consumers or to other electric systems
Turbine: a machine for generating rotary mechanical power from the thermal energy of steam
Voltage (volts): the difference in electrical potential between any two conductors or between a conductor and ground. It is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors
Wye: a method of wiring for a three-phase connection in which all three phases are connected to a common point, usually an electrical ground; when drawn in a line diagram, the shape resembles a "Y"

Unit 3 – Compliance and Application Procedures

Confined space: a space that is not designed for continuous, sustained occupancy that has limited openings for entry, exit, or ventilation; confined spaces may pose a hazard due to gas, vapor, dust, or fume levels because of the enclosed nature of the space, its location, contents, or the work activity being done
CPR: cardiopulmonary resuscitation, an emergency procedure that involves giving artificial breathing and heart massage to someone who is not breathing or does not have a pulse (requires special training)
Current: movement of electrical charge
De-energization: shutting off the energy sources to circuits and equipment
Emergency response plan: detailed procedures for responding to an emergency for the purpose of maintaining order and minimizing the effects of the emergency
Employee proficiency: skills and knowledge of employees trained and qualified to perform the skills necessary to work safely, effectively, and efficiently
Energized (alive, live "hot")**:** electrically connected to a source of potential difference, or electrically charged; a voltage present that can cause a current, creating is a possibility of getting shocked
Enforcement: the application of sanctions against a company, by an authoritative regulatory group, for the purpose of penalizing and correcting noncompliance with required standards or conditions
Ergonomics: the study and planning of the interaction between people and the work environment to reduce the potential for injury; usually focuses on the interaction between workers and the equipment they use
First aid: the immediate care given to a person who is injured or who suddenly becomes ill, to minimize injury
Ground fault circuit interrupter(GFCI): a protective device that detects current leakage from a circuit to ground and shuts the current off to prevent electrical shock
Grounding: physical electrical connection of one or more conductive objects to the earth through the use of metal grounding rods or other devices as protection against electrical shock
Hazard: the potential of any machine, equipment, process, material, or physical factor to have a harmful effects on people, property, or the environment
Hazardous energy: a voltage at which there is sufficient energy to cause injury
Health=defined by the World Health Organization as more than just the absence of disease; a state of physical, metal, and social well-being

Housekeeping: general cleanliness and neatness, including disposal of wastes, clean-up of spills, and maintaining clean work areas
Investigation: the process of systematically gathering and analyzing information about an incident for the purposes of identifying causes and making recommendations to prevent future occurrences
Job task analysis: the identification, examination, and evaluation of particular job tasks for the purpose of controlling workplace health and safety hazards
Lockout: applying a physical lock to the energy sources of circuits and equipment after they have been shut off and de-energized to prevent accidental energization material safety data sheet (MSDS): a form that contains detailed information about possible health and safety hazards of a specific material and suggestions for proper storage, use, and handling
Musculoskeletal injuries: injuries to the system of muscles, tendons, ligaments, joints, bones, and related structures of the human
Occupational injury: an injury, condition, or sickness from exposure to a workplace hazard
Occupational safety: the maintenance of a work environment that is relatively free from actual or potential hazards that can injure employees
Occupational Safety and Health Administration (OSHA): the federal agency within the U.S. Department of Labor that establishes and enforces occupational health and safety regulations
Personal protective equipment (PPE): clothing or devices worn to help protect a person from direct exposure to a hazardous material or station; examples include protective clothing, respiratory protection, and eye protection
Resistance: a material's ability to decrease, oppose, or stop electrical current
Safety policy: a statement of intent and pledge for action and commitment to a safe workplace; a policy should present clear objectives to provide direction for a health and safety program
Safety program: an established program of activities, procedures, standards, and guidelines designed to create and maintain a safe and healthy workplace
Tagout: securing a prominent warning device, such as a tag, to energy isolated devices that indicate that the energy isolating device(s), and the equipment and circuits being controlled, cannot be energized until the tagout device is removed by the person who installed it
Work practices: procedures for completing specific work tasks to ensure that a worker's exposure to hazardous situations, substances, or physical agents is removed or controlled by the manner in which the work is done
Workplace inspection: a regular and careful check of a workplace to identify health and safety hazards for the purpose of recommending corrective actions

Unit 4 – Electric Power Generation Part I

Air heater: heat transfer apparatus through which air is passed and vented; it makes use of a medium of higher temperature, such as the products of combustion
Amperage: number of electrons moving past a fixed point in a conductor in one second; the amount of electricity flowing through a wire
Amps: common abbreviation for amperes, the unit of measurement used to describe the flow of electrons (current)
Armature windings: conductor windings embedded in the stator core of the generator that make up the electrical circuit of the generator; the armature windings lead to the conductors that move the electrical energy to the main power transformer

Ash hopper: the portion of the furnace where the bottom ash falls and is removed by an ash sluice system that carries it to a holding tank or settling pond
Base load demand: the amount of power that must be made available to meet average minimum customer demand
Base load power plant: plants that operate continuously at maximum output
Boiler: a closed vessel in which water or other fluids is heated enough to be converted into steam
Boiler feed pump: a pump that constantly replenishes the water in the steam drum; it must operate at a high enough pressure to overcome the pressure in the boiler
Boiling water reactor: a boiling water reactor (BWR) is a reactor in which water is used as both a coolant and a moderator; the water is allowed to boil in the core and this produces steam which is used to drive a turbine and electrical generator, and produce electricity?
Bottom ash: the heavy ash that is removed from the furnace section by allowing it to fall into the bottom section of the furnace; it is comprised of unburned carbon as well as impurities found in the coal that does not burn
British thermal unit (Btu): a unit of energy in the English system, defined as the energy required to raise the temperature of one pound of water by one degree Fahrenheit
Chain reaction: a fission reaction that keeps itself going due to more and more neutrons being released; depending on how fast neutrons are released, a chain reaction can be controlled or uncontrolled
Chemical energy: potential energy stored in the bonds between atoms in a molecule
Combustion: when a substance (fuel) combines rapidly with oxygen (usually in the presence of heat) to produce new compounds and gives off heat; generally referred to as “burning”
Condensate: the water leaving the condenser hot well for reuse in the boiler; the condensing operation is the largest water system in the power plant
Condenser: condenses the steam into water after it has been exhausted from the turbine
Containment building: a concrete and steel enclosure around a nuclear reactor that confines fission products that otherwise might be released to the atmosphere
Control rod: a rod, plate, or tube containing a material such as cadmium or boron which is used to control the power of a nuclear reactor. By absorbing neutrons, a control rod slows down or stops a chain reaction
Critical mass: the smallest mass of nuclear material that will support a chain reaction
Current: the flow of electrons
Dam: a barrier constructed across a waterway to control the flow or raise the level of water
Desecrating heater: this heater adds heat to the feedwater and also removes the dissolved gases
Demineralizer system: the system for treating makeup water to assure that the water is free of solids and gases
Economizer—a heat-recovery device designed to transfer heat from the products of combustion to feedwater
Electrical energy: potential energy and kinetic energy associated with the position or movement of electrical charge
Electric power distribution: the transfer of high voltage electrical energy from substations to the end customer
Electric power generation: process of creating electrical energy from other forms of energy
electric power transmission: the bulk transfer of high voltage electrical energy from its source at generating plants to substations

Energy: the ability to do work
Electrostatic precipitator: a device for removing small particles (such as smoke, dust, or oil) from a gas, such as air, by passing the gas first through an electrically charged screen that gives a charge to the particles, then between two charged plates where the particles are attracted to one surface
Energy efficiency: the amount of useful energy in a system's output compared to its input
Evactor: a pump added to the condensate system that helps to ensure a vacuum and that prevents air from accumulating around the condenser tubes
Exhauster: a fan used to draw the pulverized coal dust out of the mill and blow it into the furnace; recent units have eliminated the exhauster and rely instead on increased primary air flow to the mill to transport the pulverized coal into the furnace
Feedwater heater: device that uses steam extracted from the turbine to increase the temperature of the water from the hotwell before it is reintroduced to the steam drum
Feedwater regulator: this regulator controls the water flow automatically and maintains the drum level to a constant in the boiler
Fly ash: the very fine particulates (light ash) carried through the system by the combustion gases
Fossil fuel: a hydrocarbon such as petroleum, coal, or natural gas, derived from prehistoric plants and animals and used for fuel
Forced-draft fan: a fan supplying preheated air under pressure to the fuel-burning equipment
Friction: A force that opposes relative motion of two solids or a solid and a liquid
Fuel assembly: structured collection of fuel rods within a nuclear reactor
Fuel rod: a long, slender tube that holds nuclear fuel pellets for reactor use; fuel rods are bundled together in assemblies and placed into the reactor core
Furnace: the portion of the generating unit containing the fire and fuel-burning equipment; the site where the chemical energy of the fuel is converted to thermal energy
Generator: the portion of the generating unit where the rotating mechanical energy is converted to electrical energy. It consists of a stator containing the armature windings and a rotor (center shaft) that is turned by the turbine to produce the magnetic field
geothermal energy: energy from deep under the Earth's surface
Heat exchanger: a device that moves heat from one fluid (liquid or gas) to another fluid or to the environment
Hotwell: the collection system in place in the boiler to reuse the condensate water from the condenser
Hydrocarbons: simple compounds containing only the elements hydrogen and carbon; fossil fuels are made of hydrocarbons
Hydroelectric power: power generated by using moving water to power a turbine generator to produce electricity
Igniter: device that raises the fuel/air temperature to the point of combustion
Induced-draft fan: a fan exhausting combustion gases from the heat-absorbing equipment
Kindling temperature: the temperature at which fuel ignites
Kinetic energy: energy possessed by an object or system in motion
Law of energy conservation: The total energy of an isolated system is constant; energy can be neither created nor destroyed
Load following power plant: plant that has the ability to adjust its power generation in response to change in demand throughout the day

Makeup water: water that is added to the hotwell to maintain the required level; it is pure and free from foreign matter
Mechanical energy: energy in a mechanical system; can be potential, kinetic or gravitational
Meltdown: a severe nuclear reactor accident that happens when a nuclear power plant system fails and causes the reactor core to no longer be properly controlled and cooled; this causes the nuclear fuel to melt, and releases radiation
Neutron: a fundamental subatomic particle that has nearly the same mass as the proton and no charge
Nuclear energy: the energy given off by a nuclear reaction (fission or fusion) or by radioactive decay
Nuclear fission: the splitting of an atom's nucleus into at least two smaller nuclei and the release of a large amount of energy (heat); two or three neutrons are usually released during this reaction
Nuclear Regulatory Commission: the U.S. regulatory agency that develops and enforces policies governing nuclear reactor and nuclear material safety
Nucleus: the center of an atom
Peak load demand: customer electricity demand level that is significantly above base load demand
Peaking power plant: plant that is able to respond quickly to meet the needs of energy consumers in times of highest demand for and use of electricity
Potential energy: energy stored in an object due to its position/location
Pressurized water reactor: a pressurized water reactor (PWR) is a nuclear reactor in which heat is transferred from the core to an exchanger by high temperature water kept under pressure in the primary system; steam that turns turbines is generated in a secondary circuit
Primary air: air that carries the pulverized coal into the furnace
Pulverized burning: the process of reducing coal to powder fineness for the purpose of instant combustion when it is blown into the furnace
Radioactive: emitting radiation due to decaying atomic nuclei
Radioactivity: a description of some elements that spontaneously give off energetic particles from their nuclei
Reactor vessel: the main steel vessel containing the reactor fuel, moderator and coolant
Reheater: a heater that reheats the steam after it has been through part of the turbine
Reprocessing: chemical treatment of spent reactor fuel to separate uranium and plutonium and possibly other radioactive elements from other waste products
Rotor: The rotating shaft in an electrical generator that produces the moving magnetic field that induces current flow in the armature windings of the stator
Secondary air: additional air flow to the furnace to ensure sufficient oxygen for complete combustion of the fuel
Slag: the product resulting when molten boiler ash cools into granules
Sluice system: a system that collects ash from the ash hopper and then forwards it to a holding tank or settling pond
Stator: the stationary shell of an electrical generator that contains the armature windings
Stoker firing—automated method of feeding coal pieces to early furnaces either by conveyer or hopper- fed rotating paddle wheel
Superheater: an arrangement of tubes in the gas path of the furnace to raise the temperature

of the steam above its saturation temperature
System load: the amount of electric power delivered or required at any specific point or points on a system; the requirement originates at the energy-consuming equipment of the consumers
Thermal energy: the internal energy possessed by substances in the vibration and movement of their atoms or molecules
Turbine: a machine for generating rotary mechanical power from a fluid flow (air, steam, water)
Unit: the assembly of equipment required to produce electric power from one main generator; the main pieces of equipment that comprise a unit are the steam generator (boiler or nuclear reactor), the turbine, and the main power generator
Voltage: the difference in electrical potential between any two conductors or between a conductor and ground. It is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors
Volts: the unit of measurement for voltage
Waterwall tubes: closely-spaced tubes lining the furnace and connected to the steam drum, where the primary steam is generated

Unit 4 Part II

British thermal unit (btu): a unit of energy in the English system, defined as the energy required to raise the temperature of one pound of water by one degree Fahrenheit
Chemical energy: the energy stored in the bonds and atoms and molecules
Chemical reaction: a process that leads to the change of once chemical substance to another
Combustion: when a substance (fuel) combines rapidly with oxygen (usually in the presence of heat) to produce new compounds and give off heat; generally referred to as "burning"
Dam: a barrier constructed across a waterway to control the flow or raise the level of water
Distillate fuel oils: one of the petroleum fractions produced in distillation; it is clean and free from sediment and is used primarily for space heating, diesel engine fuel, and electric power generation
Electrical energy-energy from the movement of electrons
Energy: the property of a system or object that enables it to do work
Enriched uranium: uranium ore (U238) that has the isotope of uranium that can be split (U235) added to it for use as nuclear reactor fuel
Fission: the splitting of a nucleus into at least two smaller nuclei and the release of a large amount of energy; two or three neutrons are usually released during this reaction
Fossil fuel: a hydrocarbon such as petroleum, coal, or natural gas, derived from prehistoric plants and animals and used for fuel
Fractions: the parts that petroleum separates into when distilled
Friction: the force that oppose motion
Fuel rods: sealed tubes containing pellets of nuclear fuel
Generator: the portion of the generating unit where the rotating mechanical energy is converted to electrical energy; it consists of a stator containing the armature windings and a rotor (center shaft) that is turned by the turbine to produce the magnetic field
Gravitational energy: the energy of position or placement

Greenhouse gases: the parts of the atmosphere, both natural and manmade, that trap and hold heat within the earth's atmosphere
Hydroelectric power: power generated by using moving water to power a turbine generator to produce electricity
In-situ leach mining: process for extracting uranium or other minerals by drilling holes into the deposit and flooding it with a chemical solution that will dissolve the deposit and then pumping that solution to the surface and extracting the minerals from the ore
Kinetic energy: energy of motion
Motion energy: energy from the movement of objects from one place to another
Neutron: a fundamental subatomic particle that has nearly the same mass as the proton and no charge
Nonrenewable energy: energy sources that have a limited supply
Nuclear energy: the energy given off by a nuclear reaction (fission or fusion) or by radioactive decay
Nucleus: the center of an atom
Open pit mining: process for extracting coal or other materials by removing layers of earth ore-rock containing the desired mineral; raw materials from which a mineral is extracted
Potential energy: energy of position; stored energy
Radiant energy: electromagnetic energy
Radioactive decay: process by which an unstable nucleus emits radiation and becomes more stable
Refinery: an industrial plant where crude oil is processed into useful products
Renewable energy: energy sources that can be replenished in a short period of time
Reprocessing: chemical treatment of spent reactor fuel to separate uranium and plutonium and possibly other radioactive elements from other waste products
Residual fuel oils: residual fuel oil is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes
Spent nuclear fuel: fuel rods that have been depleted of useful fuel; fuel that has been used to the extent that is can no longer effectively sustain a chain reaction
Stored mechanical energy: the energy stored in objects by the application of a force
Thermal energy: internal energy due to vibration and movement of molecules
Turbine: a machine for generating rotary mechanical power from a fluid flow (air, steam, water)
Viscosity: viscosity can be thought of as the thickness of a fluid that determines how easily it flows; lower viscosity means that the fluid is "thin" and flows more easily
Yellowcake: uranium powder mined through in-situ leaching; it is processed to produce uranium fuel used in nuclear reactors

Unit 4 Part III

Active solar heating: use of sunlight to heat liquid that is then piped to heat water or the house itself
Alternative energy: energy derived from nontraditional sources as an alternative to fossil fuel use; does not necessarily mean renewable
Anaerobic digestion: the process by which microorganisms break down biodegradable material in the absence of oxygen

Binary cycle plant: a geothermal power plant that uses heat from lower-temperature geothermal resources to vaporize a secondary fluid with a lower boiling point than water; the temperature difference between the two fluids causes the creation of vapor which drives a turbine to generate electricity
Bioenergy: energy produced from a biological resource such as biomass
Biomass: biological material derived from living or recently living organisms, such as wood, waste, plant matter and other organic materials that can be used as an alternative energy source
Biomass power generation: the generation of electricity from organic materials
Dam: a barrier constructed across a waterway to control the flow or raise the level of water
Dry steam plant: a geothermal power plant that uses superheated steam that comes directly from the geothermal heat source
Ebb generation: A type of tidal generation, it allows water to enter the barrage through special gates without the turbines running; the water is trapped at high tide by closing the gates and then generating power by releasing the water at ebb tide
Estuary: the area of water where a river meets the ocean
Flash steam plant: a geothermal power plant that uses high-pressure hot water; pressure differences between the well and the storage device cause the water to vaporize into steam that turns a turbine and generates electricity
Flood generation: generation of power by allowing the turbines to operate as the tide comes in
Gasification: process of transforming carbon-based materials into a useful fuel through high heat combustion in a controlled environment
Generator: the portion of the generating unit where the rotating mechanical energy is converted to electrical energy; it consists of a stator containing the armature windings and a rotor (center shaft) that is turned by the turbine to produce the magnetic field
Geothermal energy: energy derived from the natural heat resources within the earth
Hydrokinetic energy: energy that is the result of water movement such as tides and currents
Megawatts: one million watts
Passive solar heating: use of direct sunlight to heat water or a house
Photovoltaic cell: a device that uses the photovoltaic effect to convert sunlight into electricity
Photovoltaic effect: the chemical reaction of the creation of an electric current in a material that has been exposed to solar radiation
Photovoltaic (PV) energy: conversion of sunlight into electricity
Renewable energy: energy which comes from natural resources which are renewable (naturally replenished)
Subsidence: gradual settling or sinking of a land surface often associated with the following: seismic activity, underground excavation, or underground pumping
Tidal barrage: a structure built across an estuary with gates and turbines installed to funnel and use the tidal forces to generate electricity
Turbine: a machine for generating rotary mechanical power from a fluid flow (air, steam, water)
Two-way operation: generates power by allowing the turbines to operate as the tide comes in and as it recedes
Watt: the basic unit of power

Unit 5- Electric Power Transmission Part I

Alternating current (AC): an electric current that reverses its direction at regularly recurring intervals
Circuit breaker: device that protects a transformer from being overloaded with current and malfunctioning or blowing
Conductor: materials such as copper and aluminum that allow electrical current to flow freely through them; in electric power transmission, conductor is also the term used for the actual "power line" or cable
Corona loss: energy loss that results from electrical stresses at the conductor surface and result in ionization of the surrounding air
Current (amps): a flow of electrons in an electrical conductor; the strength or rate of movement of the electricity is measure in amperes (amps)
Direct current (DC): current which moves in only one direction; DC results from a constant polarity power source
Distribution circuit: circuits that transmit lower voltages from the substation
Distribution system:the portion of the transmission and facilities of an electric system that is dedicated to delivering electric energy to an end user
Electric power transmission: the bulk transfer of high voltage electrical energy from its source at generating plants to substations
Electric power transmission system: an interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers or is delivered to other electric systems
Electrical energy: electrical energy is the generation or use of electric power over a specified amount of time; electrical energy is expressed in kilowatt-hours (kWh)
Electrical power grid: interconnected electric generation, transmission, and distribution systems over broad geographic areas
Frequency: the number of cycles of alternating polarity per second; an AC voltage source reverses the direction of electric charge many times per second; measured in cycles per second (hertz or Hz)
Generating plant switchyard: where power is transformed and routed to the transmission system
Generator: the portion of the generating unit where the rotating mechanical energy is converted to electrical energy; it consists of a stator containing the armature windings and a rotor (center shaft) that is turned by the turbine to produce the magnetic field
Ground wires: set of wires attached directly to the transmission tower so that current from a lightning strike flows to the ground; also called shield wires0
Hertz (Hz): cycles per second; the unit of measurement for frequency
Insulators: materials such as glass and fiberglass that do not allow electrical current to flow through them; in electric power transmission, the term insulator also refers to the piece of equipment that is used to attach transmission lines that support the conductor and other conductor attachment points.
Load (electric): the amount of electric power required by consumers (demand)
Oscilloscope: an electronic measuring instrument that displays the waveforms created by an electrical current

Power: in the context of electricity transmission, power is defined as a rate at which electricity (electrical energy) is produced; power is measured in watts (W) or megawatts (MW); power is a variable that must be considered when dealing with transmission system capability and capacity design and function
Reactance: opposition to the flow of an alternating electric current caused by the buildup of electric or magnetic fields due to the current
Resistance: a measure of the degree to which an electrical component opposes the passage of current; resistance is measured in ohms
Right of way (ROW): the right of way for a transmission system consists of the land set aside solely for the use of transmission towers, lines, and other facilities; right of ways serve as safety mechanisms to maintain clearance areas between the transmission lines and surrounding structures or trees and other vegetation
Step-down transformer: a transformer that has more turns in the primary winding than in the secondary winding; voltages are higher in the primary circuit than in the secondary circuit
Stepped down: conversion of high- voltage electricity to lower voltage through the use of transformers at power substations
Stepped up: conversion of high-voltage electricity to higher voltage through the use of transformers at power substations
Step-up transformer: a transformer that has fewer turns in the primary winding than in the secondary winding; the voltage in the primary circuit will be less than in the secondary circuit
Substation: a location along a transmission or distribution route containing equipment to transform and route power
Subtransmission system: a subsystem of the electric power transmission system that carries voltages that are reduced from the major transmission line system that is typically routed to distribution stations
Switching station: also known as a switchyard, it is the area at a generating station that transforms and routes power to be entered into the transmission system
Thermal limit: the maximum amount of power a transmission line can carry without experiencing heat-related deterioration
Transformer: a device that transfers power from one circuit to another; step-up transformers increase voltage from the primary to the secondary circuit while lowering current proportionally, while step-down transformers lower voltage from the primary to the secondary circuit while raising current proportionally
Transmission: see “electric power transmission”
Transmission system: see “electric power transmission system”
Transmission switching: the connecting and disconnecting of transmission lines or other components to and from the system
Transmission tower: the rigid support structure that is used to support electric power transmission conductors (cables)
Voltage (volts): the difference in electrical potential between any two conductors or between a conductor and ground; it is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors
Voltage drop: a reduction in voltage between the source and load in an electrical circuit caused by electrical resistance

Unit 5 Part II

Balancing authority: a regional organization responsible for planning for and maintaining the balance of electricity resources and electricity demand
Blackout: power loss affecting many consumers over a large geographical area for a significant period of time
Brownout: a planned partial reduction in the voltage of electrical power service
Federal Energy Regulatory Commission (FERC): an independent regulatory agency within the Department of Energy and the successor to the Federal Power Commission; it governs interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certification
High temperature superconducting (HTS): a technology for transmitting electricity that uses special conductors designed to improve transmission capabilities
Independent system operator (ISO): created under the authority of FERC; designed to administer the transmission grid on a regional basis in a neutral manner
Load balancing: meeting fluctuations in demand or matching generation to load to keep the electrical system in balance
Load shedding: process by which an electric utility removes power demand from a power system (cuts electricity to certain customers) to maintain system integrity
North American Electric Reliability Corporation (NERC): formed in 1968 in response to the 1965 blackout, NERC is the electric reliability organization certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk-power system; all bulk-power system owners, operators, and users are required to register with NERC
Regional transmission organization (RTO): created under the authority of FERC; designed to administer the transmission grid on a regional basis in a neutral manner; FERC stated that entities desiring to be qualified as RTOs must first meet a specific list of characteristics and functions
Rolling blackout: a controlled, temporary interruption of electrical power service; typically imposed by a utility over portions of a service area to meet heavy demand and when there is a deficiency in the supply of power?
Scheduled outage: when a portion of a power system is intentionally shut down, usually to allow for maintenance or other preplanned activities
Smart grid: modernization of the current grid technology; has the ability to monitor energy flow and communicate data back to utility companies; use of smart meters, distributed generation allowing smaller power sources to feed energy back into the grid, store energy generated in off-peak hours and distribute it during peak hours
Supervisory control and data acquisition (SCADA): a system of remote assessments used to monitor and control the electric transmission system

Unit 6 –Electric Power Distribution Part I

Alternating current (AC): an electric current that reverses its direction at regularly recurring intervals
Automatic meter reading (AMR): the use of devices with remote reading capabilities to collect information from an electric meter

Capacitor: a piece of equipment used in electric power distribution systems that assist in regulating and controlling voltage through temporary power storage capabilities
Conductor: material such as copper or aluminum that allows electrical current to flow freely through it; in electric power transmission and distribution, conductor also refers to the actual "power line" or cable
Control house: a structure that is built within the substation yard that houses electric power distribution monitoring and control equipment
Current: a flow of electrons in an electrical conductor; the strength or rate of movement of the electricity is measured in amperes (amps)
Delta: a method of wiring for a three-phase connection in which three windings of a transformer or generator are connected end to end; when drawn in a line diagram, the shape resembles the Greek letter delta (δ)
Distribution bus: a structure commonly found at a distribution substation that is composed of switches that route power out of the substation
Distribution circuit breaker: a piece of equipment designed to protect components in an electric distribution circuit in the event of a system failure or problem
Distribution circuit regulator: a piece of equipment that adjusts voltage levels in distribution circuits to maintain a constant voltage level in the system
Distribution feeder circuit: the connections between the electrical power output of a distribution substation and the input terminal of distribution primary circuits
Electric meter: a device that measures the amount of power consumed, typically in kilowatt-hours (kWh)
Electric power distribution system: an interconnected group of electric distribution lines and associated equipment for transferring electric energy from points where it is transformed for delivery over the distribution system lines to consumers
Electric power distribution: the movement of electrical energy from distribution substations to end-use customers
Ground wire: a wire that is installed to span the entire length of a utility pole and into the ground that provides a safe path for unintended power to travel away from the distribution system components and into the earth (ground)
Insulator: material such as glass or fiberglass that does not allow electrical current to flow through it; in electric power distribution, insulator also refers to the actual piece of equipment that is used to attach distribution lines that support the conductor and at other conductor attachment points
Interconnected distribution network: a type of distribution network that consists of a system of distribution lines that are connected to multiple power sources
Kilowatt-hour: a unit signifying 1,000 watts of electricity used in 1 hour; used for customer billing
Load (electric): the amount of electric power required by consumers (demand)
Primary circuit: the distribution circuit that carries electrical power from a substation to a local distribution service area
Radial distribution network: a type of distribution network that consists of a system of distribution lines that are connected to only a single power source
Regulator: a piece of equipment used in electric power distribution systems that assist in regulating voltage in distribution lines
Resistance (ohms): a measure of the degree to which an electrical component opposes the

passage of current; resistance is measured in ohms
Right of way (ROW): the right of way for a distribution system consists of the land set aside solely for the use of distribution towers or poles, lines, and other facilities; right of ways serve as safety mechanisms to maintain clearance areas between the distribution lines and surrounding structures or trees and other vegetation
Service drop: common name for the distribution lines or wires that connect a distribution transformer to a customer's house or place of business
Step-down transformer: a transformer that has more turns in the primary winding than in the secondary winding; voltages are higher in the primary circuit than in the secondary circuit
Stepped down: conversion of high- voltage electricity to lower voltage through the use of transformers at power substations
Substation:
location along a transmission or distribution route containing equipment to transform and route power
Subtransmission: the transfer of stepped-down voltage from the transmission system to the distribution system
Subtransmission system: a subsystem of the electric power transmission system that carries voltages that are reduced from the major transmission-line system that is typically routed to distribution stations
Switching station: also known as a switchyard, which is the area that is at a generating station that transforms and routes power to be entered into the transmission system
Telemetry: the wireless automatic transmission of data, usually for the purpose of remote monitoring
T**ransformer**: a device that transfers power from one circuit to another; step-up transformers increase voltage from the primary to the secondary circuit while lowering current proportionally, while step-down transformers lower voltage from the primary to the secondary circuit while raising current proportionally
Voltage (Volts): the difference in electrical potential between any two conductors or between ta conductor and ground; it is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors
Wye: a method of wiring for a three-phase connection in which all three phases are connected to a common point, usually an electrical ground; when drawn in a line diagram, the shape resembles a "Y"

Unit 6 Part II

Advanced metering infrastructure (AMI): smart meter technology systems that employ enhanced communication technologies that automatically measure and report power usage information
Demand response: mechanisms or systems that enable the strategic management of electricity consumption (demand) in response to supply conditions; demand response systems can enable customers to take advantage of lower energy prices while improving the reliability of the grid
Scheduled outage: when a portion of a power system is intentionally shut down, usually to allow for maintenance or other preplanned activities
Smart grid: modernization of the current grid technology; has the ability to monitor energy

flow and communicate data back to utility companies; uses smart meters; participates in distributed generation allowing smaller power sources to feed energy back into the grid; stores energy generated in off-peak hours and distributes it during peak hours
Smart meter: a specialized electric power meter that measures the amount of power consumed and has the ability to communicate information between the meter and a central communication system
Supervisory control and data acquisition (SCADA): a system of remote assessment used to monitor and control the electric transmission system
Unplanned outage: an interruption or failure of electrical service that is unintentional and unexpected

Unit 7- Careers in Energy

Absenteeism: consistent failure to show up for work
Computer literacy: An understanding of how computers work and what they are used for.
Confidentiality: privacy of information.
Critical thinking skills: The skills required to evaluate and use information to make decisions or reach conclusions.
Goal-oriented: To be focused on an objective.
Harassment: a type of discrimination that can be based on race, age, disabilities, sex, religion, cultural issues, health, or language barriers.
Leadership: the ability to set an example for others to follow by exercising authority and responsibility.
Mission statement: a statement of how a company does business.
Professionalism: Integrity and work appropriate manners.
Reference: a person who can confirm to a potential employer that you have the skills, experience, and work habits that are listed in your résumé more.
Self-presentation: The way a person dresses, speaks, acts, and interacts with others.
Tactful: Aware of the effects of your statements and actions on others.
Teamwork: The cooperation of coworkers to achieve one or goals.
Work ethic: Work habits that are the foundation of a person's ability to do his

Unit 8- Energy Innovations-to be developed by teachers as taught

Unit 9- Importance of Alternative Energy

Alternative energy: Energy that is provided by means not related to fossil fuels. Most forms of alternative energy are considered renewable, but not all.
Base load unit: An electrical power-generating unit that has the primary mission of supporting basic power needs and typically operates on a full-time basis. A base load is considered the lowest amount of electrical power that is required to satisfy consumer needs at any time.
Fuel: A fuel that originates from an organic, renewable source, such as ethanol or methane.
Biomass: Fuel that originates from living or recently living organic matter, generally with little or no processing before use.
Centralized power generation: The generation of electric power in large volumes at a single location to serve many consumers. Most locations fitting this description are fossil fuel, nuclear,

or hydroelectric facilities.
Cogeneration: The simultaneous generation of usable electric power and heat from a single source or process; also known as combined heat and power (CHP).
Combined heat and power (CHP): The simultaneous generation of usable electric power and heat from a single source or process; also known as cogeneration.
Concentrated solar thermal (CST): The process of generating energy by concentrating the sun's power to a single point heating liquids to create steam or high-temperature liquids. The medium can be stored to allow for power generation when solar power is not available.
Electric grid: The electrical infrastructure that transmits and distributes power across the United States.
Fuel cells: Devices that generate electrical power by using the chemical energy released by a fuel and oxidant reaction.
Gasification: Any chemical or heat process that results in changing a substance into a gas. Gasification is used to transform biomass and other solids into a useful gas, commonly known as syngas.
Greenhouse gases: Gases that contribute to the Earth's warming by trapping and reflecting solar radiation and heat back towards the planet. CO2 and ozone are the two primary greenhouse gases.
Gross domestic product (GDP): The final value of all goods and services produced within the borders of a country during some period. Several methods can be used to determine the total value. Government or public spending is often separated from all other spending.
Interconnection agreement A contract between a utility and a power provider that outlines the specific means of connection and how both parties will be compensated.
Kilowatt (kw): One thousand watts.
Kilowatt-hour (kWh): The primary unit used to bill for the consumption of electric power. For example, one kWh is equal to the use of one kW of power for one hour, or the use of two kW of power for 30 minutes.
Megawatt (mw): One million watts.
Microgrid: A small power grid that typically includes several forms of power generation and the primary users.
Net metering: A system of monitoring power coming into the grid as well as grid power used by a consumer. In most cases, the electric meter can turn in either direction.
Peaking load unit An electrical power-generating unit used to satisfy electrical demands that are above the volume considered the base load. Peaking load units are operated intermittently as needed.
Phantom loads: Devices that use electrical power even when they are not turned on or actively engaged in their design function.
Photovoltaic (pv): Describes the process of transforming light energy into electrical power.
Renewable energy: Energy that comes from a source that is naturally renewed or sustained. Renewable energy sources are also considered alternative energy sources.
Renewable portfolio standard (rps): Also known as a Renewable Electricity Standard at the federal level. An RPS outlines the state-required production or procurement of power generated from renewable energy sources by utility companies and other power providers.
Smart grid: A digitally enhanced grid system to allow greater control of both loads and power resources.
Solar thermal energy (ste): Energy that uses solar power to generate heat

Superconductors: Elements or metallic alloys that are capable of conducting electrical power with little or no resistance to flow, eliminating losses. Typically, these materials function this way at a temperature near absolute zero; however, new discoveries of materials that exhibit this characteristic well above absolute zero give hope for future materials that can do so at normal temperatures.
Utility-scale: Power generation on a scale that is usable and significant to utility companies. The power may be generated by the utility's own systems or by others who sell power to the utility directly. Utility-scale power generating systems are typically listed with the DOE as such a facility.
Watt: An SI unit of power measurement equal to the power produced when a current of one ampere flows at a potential electrical difference of one volt One watt is equal to one joule per second.
Zero energy district: An area that seeks to both reduce power consumption and generate all needed power from local alternative sources.

Unit 10-Biomass and Biofuel

Anaerobic digester: Equipment used to recover methane and other byproducts by using bacteria to break down organ matter in an oxygen-free environment.
Biogenic: produced by living organism, such as methane
Cellulose: the fibrous carbohydrate found the walls of green plants cells; cellulose gives strength and rigidity to plants
Convection- the transfer of heat through a gas or liquid by distribution of heat through currents of air circulating within a closed area
Cropland: the total area of land used for crops, pastures, and idle land. Idle land is land that has been cultivated but is now unused.
Distributor plate: the supporting plate or grate in the bottom of a gasifier, perforated by nozzles, holes, or other pathways that allow air penetration into the feedstock resting on the plate.
Metabolic: refers to processes that make energy and matter available to cells. Any reaction in a living organism that builds and breaks down organic molecules and produces or consumes energy in the process is metabolic.
Microbes: very tiny living organisms, visible through a microscope, such as bacteria, funguses, or viruses.
Municipal solid wastes (MSW): the kind of garbage found in a landfill.
Pyrolysis: a process in which biomass is subjected to heat greater than 400 degrees Fahrenheit to remove the volatile matter and change the remaining material to charcoal and oil. Volatile matter is the material given off as vapor or gas, but it does not include water vapor.
Stover: the leftover parts of corn after harvest, including stalks, leaves, and husks.

Unit 11- Nuclear Power

Boiling water reactor (BWR): A light water nuclear reactor in which the water boils in the reactor core and is drawn up through a separator in the top of the pressure vessel. The water is separated from the vapor, which is sent directly to a steam turbine.
Breeder reactor: A reactor that creates more fissionable material than it uses.
Core: The central part of a nuclear reactor where fission occurs.

Fission: The splitting of atoms, which releases a tremendous amount of energy in the form of beat.
Fracturing: A mining process used to break or separate rock, usually by injecting fluid into a hole, either natural or manmade, under high pressure.
Fusion: The process in which atomic nuclei collide so fast they stick together and emit a large amount of energy. In the center of most stars, hydrogen fuses into helium.
Heavy water: Water laced with a large number of molecules that contain deuterium atoms; deuterium is also called heavy hydrogen.
Heavy water reactor: In most reactors, the moderator is plain water; but some reactors use heavy water, which does not absorb neutrons as regular hydrogen does, making it useful in slowing neutrons from fission.
Light water reactor A nuclear reactor that uses plain water as a coolant and moderator.
Parabolic cooling tower: An upright cooling tower with a "waist" The shape induces a natural draft, drawing air in at the bottom and forcing it out at the top.
Photons: An individual particle of electromagnetic energy such as light; a basic unit that has no mass.
Pressurized water reactor (PWR): A type of light water reactor is which the water is kept under pressure and not allowed to expand, so it gets hotter and hotter but stays in its liquid state, creating enormous pressure. The superheated pressurized water is carried to a steam generator where it is used to produce steam.
roentgens per man (rems): A quantity that relates to the amount of damage to the human body an absorbed dose of radiation could (but does not necessarily) cause. It is often expressed in thousandths of a rem, or millirems.
tertiary: Belonging to the third level or order.
vitrification: The conversion of a material into extremely hard glass by subjecting it to temperatures lower than its normal melting point.

Unit 12- Solar Power

Air mass: The thickness of the atmosphere that solar radiation must pass through to reach Earth.
Altitude: The angle at which the sun is hitting the array.
Ambient temperature: The air temperature of an environment
Amorphous: A low-efficiency type of photovoltaic cell characterized by its ability to be used in flexible forms. Also known as thin film.
Array: A complete PV power generating system including panels, inverter, batteries and charge controller (if used), support system, and wiring.
Autonomy: The number of days a fully charged battery system can supply power to loads without recharging.
Azimuth: For a fixed PV array, the azimuth angle is the angle clockwise from true north that the PV array faces.
Backfeed: When current flows into the grid.
Balance of system (bos): The panel support system, wiring, disconnects, and grounding system that are installed to support a PV array.
Brownout: A temporary decrease in grid output voltage typically caused by peak load demands.
Building-integrated photovoltaics (bipv): A PV system built into the structure as a replacement for a building component such as roofing.

Charge controller: A device used to regulate the charging and discharging of the battery system to prevent overcharge and excess discharge.
Combiner box: A junction box used to connect strings of solar panels to create a larger array, and to provide a convenient array disconnect point
Concentrating collector: A device that maximizes the collection of solar energy by using mirrors or lenses to focus sunlight onto a central receiver.
Declination: The angle between the equator and the rays of the sun.
Depth of discharge (dod): A measure of the amount of charge removed from a battery system.
Doped: A material to which specific impurities have been added to produce a positive or negative charge.
Dual-axis tracking: An array mounting system designed to adjust both the horizontal and vertical axes of a panel to precisely follow the movement of the sun.
Electrochemical solar cell: A type of PV cell that replaces silicon with a light sensitive dye that absorbs light and produces current
Elevation: A measure of a location's relative height in reference to sea level.
Evacuated tube collector: A type of solar thermal heat collector consisting of parallel rows of transparent glass tubes with a vacuum between the tubes to preserve heat.
Flat plate collector: A type of solar thermal heat collector consisting of metal box with a transparent cover that contains three main components: an absorber to collect the heat tubes containing water or air, and insulation.
Fuel cell: A device that harnesses the energy produced by a chemical reaction between hydrogen and oxygen to produce direct current
Grid-connected system: A PV system that operates in parallel with the utility grid and provides supplemental power to the building or residence. Since they are tied to the utility, they only operate when grid power is available. also known as a grid-tied system.
Grid-interactive system: A PV system that supplies supplemental power and can also function independently through the use of a battery bank that can supply power during outages and after sundown-
Grid-tied system: See rid-connected system.
Heliostats: A group of sun-tracking mirrors used to focus the sunlight on a central receiver in a solar thermal power plant
Hybrid system: A grid-interactive system used with other energy sources, such as wind turbines or generators.
Insolation: The equivalent number of hours per day when solar irradiance averages 1,000 W/m2. Also known as peak sun hours.
Integral-collector storage system: A of solar thermal system consisting of one more storage tanks in an insulated box with glazed side facing the sun.
Inverter: A device used to convert direct cur to alternating current
Irradiance: A measure of radiation density at specific location.
Latitude: A method of determining a location earth in reference to the equator.
Maximum power point tracking (mppt): A battery charge controller that provides precise charge/discharge control over a wide range of temperatures.
Module: A PV system component consisting of numerous electrically and mechanically con-PV cells encased in a protective glass or laminate frame. Also known as a PV panel.
Monocrystalline: A type of PV cell formed thin slices of a single crystal and characterized by its high efficiency.

Net metering: A method of measuring power used from the grid against PV power put into the grid.
Off grid system: A PV system typically provide power in remote areas. Off-grid s use batteries for energy storage as well battery-based inverter systems. Also known standalone system.
Polycrystalline: A type of PV cell formed pouring liquid silicon into blocks and then slicing it into wafers. This creates non-uniform with a flaked appearance that have a lower efficiency than monocrystalline cells.
Pulse width-modulated (pwm): controls that uses a rapid switching method to simulate a waveform and provide smooth power.
Sea level: A measure of the average height of ocean's surface between low and high tide. Sea level is used as a reference for all other el- on Earth.
Semiconductor: A material that exhibits the properties of both a conductor and an insulator.
Sine wave: A form presented as a ripple, representing the consistent frequency and amplitude of electrical power.
Single-axis tracking: An array mounting system designed to adjust either the horizontal or the vertical axis of a panel to follow the movement of the sun
Solar photovoltaic (pv) system: A power production system that converts sun light into electricity using a semiconductor.
Solar thermal system: A system that uses sunlight to heat air or water.
Spectral distribution: The distortion of light through Earth's atmosphere.
Standalone system: See off-grid system.
Standard test conditions (STC): Standardized panel ratings based on a specific operating temperature, solar irradiance, and air mass.
Sun path: The sun's altitude and azimuth at various times of year for a specific location or latitude band.
Thermosiphon system: A type of solar thermal system consisting of a tank mounted above one or more flat panel collectors. Thermosiphon systems rely on convection to circulate water through the collectors and to the tank.
Thin film: See amorphous.
Tilt angle: The position of a panel or array in reference to horizontal. Often set to match local latitude or in higher-efficiency systems, the tilt angle may be adjusted by season or throughout the day.
Utility-scale solar generating system: Large solar farms designed to produce power in quantities large enough to operate a small city.
Watt-hours (wh): A unit of energy typically used for metering.

Unit 13- Wind Power

Anemometer: A device used to measure wind velocity that often incorporates wind direction as well.
Betz limit: The theoretical limit of 59.3 percent of the available wind power that a rotor can capture. The theory is named for its German developer, Albert Betz.
Charge controller: A device that controls the DC power from an energy source used to charge batteries, to ensure the batteries charge to their maximum levels.
Dynamo: An apparatus that converts mechanical energy into electrical energy, typically in the form of direct current.

Effective ground level: The actual surface that air movement is passing across, as opposed to actual ground level For example, the effective ground level for a wind blowing over a dense forest would be the tops of the trees rather than the ground itself.
Furling: One method of preventing excessive wind turbine rotor speed through yaw control by turning the rotor blades away from a direct wind facing.
Horizontal-axis wind turbines (HAWTS): A wind turbine that spins on an axis which is horizontal or nearly so, much like the early windmills of the western and mid-western United States. Also referred to as a conventional turbine or propeller-style, they are directional by design; that is, the rotor must face into the wind for maximum performance.
Inverter: An electronic device that inverts a DC power source to an AC power supply.
Kinetic energy: The energy contained in a mass or body caused by its motion.
Longitudinal: Running lengthwise or extending along the length of an object A line drawn the length of an object would indicate its longitudinal axis.
Nacelle: A streamlined housing or enclosure that contains the major working components of the turbine system at the top of the tower.
Net metering: The metering approach used to accommodate renewable energy sources that are on the load or customer side of the grid, allowing power to flow in both directions and the costs credited accordingly. The meter typically records flow in both directions.
Pitch control: Controlling the longitudinal position of turbine blades as a means of rotor speed control and braking.
Power density: The means of quantifying the power available in wind per unit of area, generally expressed as watts per square meter (w/m2); in English units, it is expressed as watts per square foot (w/f t2).
Supervisory control and data acquisition (SCADA) system: A computerized system used to supervise, control, monitor, and collect historical data from an individual wind turbine or a collection of turbine systems using real-time information and commands.
Swept area; The area that turbine rotor blades pass through.
Tip brakes: Rotor blade tips designed to rotate independent of the rest of the blade, allowing it to spoil the aerodynamic characteristics and reduce rotor speed.
Vertical-axis wind turbines (VAWTS): A wind turbine with a rotor that spins on a vertical or near-vertical axis. VAWTs are generally omnidirectional and allow for the drive train and generators systems to be mounted at ground level.
Wind rose: A circular graph that depicts the frequency at which winds blow from a given direction at a given location, generally reported as a percentage of time. Wind roses may also contain other information through the use of color, such as how often the wind blows from a direction at a given velocity.
Wind shear: The wind velocity variations that occur at different heights above the earth.
Yaw control: Management of a wind turbine's facing direction by rotation of the turbine assembly on its vertical axis.

Unit 14 Generation System

Amperage: number of electrons moving past a fixed point in a conductor in one second; the amount of electricity flowing through a wire
Amps: common abbreviation for amperes, the unit of measurement used to describe the flow of electrons (current)

Armature windings: conductor windings embedded in the stator core of the generator that make up the electrical circuit of the generator; the armature windings lead to the conductors that move the electrical energy to the main power transformer
Current: the flow of electrons
Electrical energy: potential energy and kinetic energy associated with the position or movement of electrical charge
Electric power generation: process of creating electrical energy from other forms of energy
Energy: the ability to do work
Energy efficiency: the amount of useful energy in a system's output compared to its input
Generator: the portion of the generating unit where the rotating mechanical energy is converted to electrical energy. It consists of a stator containing the armature windings and a rotor (center shaft) that is turned by the turbine to produce the magnetic field
Megawatts: one million watts
Rotor: The rotating shaft in an electrical generator that produces the moving magnetic field that induces current flow in the armature windings of the stator
Stator: the stationary shell of an electrical generator that contains the armature windings
System load: the amount of electric power delivered or required at any specific point or points on a system; the requirement originates at the energy-consuming equipment of the consumers
Turbine: a machine for generating rotary mechanical power from a fluid flow (air, steam, water)
Unit: the assembly of equipment required to produce electric power from one main generator; the main pieces of equipment that comprise a unit are the steam generator (boiler or nuclear reactor), the turbine, and the main power generator
Voltage: the difference in electrical potential between any two conductors or between a conductor and ground. It is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors
Volts: the unit of measurement for voltage
Watt: the basic unit of power

Unit 15- Equipment Operation, Maintenance and Repair

Abrasive: A substance, such as sandpaper, that is used to wear away material.
Amp meter: An instrument that measures electric current in amperes
Auger: A tool with a spiral cutting edge for boring holes in wood and other materials.
Binoculars: an optical instrument for use with both eyes, consisting of two small telescopes joined together Also called field glasses
Cable crimper: a tool designed to crimp or connect a connector to the end of a cable. For example, network cables and phone cables are created using a crimping tool to connect the RJ-45 and RJ-11 connectors to the end of the cable.
Cable distance meter: is a handheld meter for measurement of cable sag, cable height distance and overhead clearance of conductors
Cable stripper: is a small, hand-held device used to strip the electrical insulation from electric wires
Calculator: An electronic or mechanical device for the performance of mathematical computations

Capacitance meter: is a piece of electronic test equipment used to measure capacitance, mainly of discrete capacitors. Depending on the sophistication of the meter, it may display the capacitance only, or it may also measure a number of other parameters such as leakage, equivalent series resistance (ESR), and inductance. For most purposes and in most cases the capacitor must be disconnected from circuit; ESR can usually be measured in circuit
Carpenter ruler: Usually a folding ruler with double measurements, metrical and imperial on both sides, may function as a conversion table
Chuck: A clamping device that holds an attachment; for example, the chuck of the drill holds the drill bit
Double-insulated/ungrounded tool: An electrical tool that is constructed so that the case is insulated from electrical energy. The case is made of a nonconductive material.
Electric tools: Tools powered by electricity; The electricity is supplied by either an AC source (wall plug) or a DC source (battery).
Ferromagnetic: Having magnetic properties. Substance such as iron, nickel, cobalt, and various alloys are ferromagnetic.
Grinder/cutter: A mechanical device that grinds
Grounded tool: An electrical tool with a three-prong plug at the end if its power cords or some other means to ensure that stray current travels to ground without passing through the body of the user. The ground plug is bonded to the conductive frame of the tool.
Ground fault circuit interrupter (GFCI): A circuit breaker designed to protect people from electric shock and to protect equipment from damage by interrupting the flow of electricity if a circuit fault occurs.
Hydraulic tools: Tools powered by fluid pressure. The pressure is produced by hand pumps or electric pumps.
Lineman pliers: also called combination pliers are a type of pliers used by electricians and other tradesmen primarily for gripping, twisting, bending and cutting wire and cable
Load bust tool: a lightweight, easy-to-use portable loadbreak tool for use with disconnects cutouts, power fuses, and fuse limiters in an overhead distribution system.
Personal Protective Equipment (PPE): clothing or devices worn to help protect a person from direct exposure to a hazardous material or station; examples include protective clothing, respiratory protection, and eye protection (equipment may include hard hat, safety glasses, boots, dielectric overshoes, Flame Retardant/arc-flash clothing, work gloves, rubber gloves [primary and secondary], cut-resistant gloves, ear plugs, road reflective vest)
Pneumatic tools: Air-powered tools. The power is produced by electric or fuel-powered compressors.
Reciprocating: Moving back and forth
Shank: The smooth part of a drill bit that fits into the chuck.
Trigger lock: A small lever, switch, or part that you push or pull to activate a locking catch or spring. Activating the trigger lock causes the trigger to stay in the operating mode even without your finger on the trigger.
Ten-inch crescent wrench:
Wire brush: primarily an abrasive implement, used for cleaning surfaces and to create a better conductive area for attaching electrical connections, such as those between an electrical post and a cable connector, should they accumulate a build-up of grime, dirt or corrosion.
Volt Meter: an instrument of high resistance for measuring differences of pressures in volts

Unit 15 Part II

Architect: A qualified, licensed person who creates and designs drawings for a construction project.
Beam: A large, horizontal structural member made of concrete, steel, wood, or other structural material to provide support above a large opening.
Blueprints: The traditional name used to describe construction drawings.
Computer-aided drafting (CAD): The making of a set of construction drawings with the aid of a computer.
Construction drawings: Architectural or working drawings used to represent a structure of system.
Contour lines: Solid or dashed lines showing the elevation of the earth on a civil drawing.
Detail drawings: Enlarged views of part of a drawing used to show an area more clearly.
Dimensions: Measurement such as length, width, and height shown on a drawing.
Electrical plans: Engineered drawings that show all electrical supply and distribution.
Elevation drawing: Side view of a building or object, showing height and width.
Floor plan: A drawing that provides an aerial view of the layout of each room.
Foundation plan: A drawing that shows the layout and elevation of the building foundation.
Hidden line: A dashed line showing an object obstructed from view by another object.
Isometric drawing: A type of three-dimensional drawing of an object.
Legend: A description of the symbols and abbreviations used in a set of drawings.
Mechanical Plans: Engineered drawings that show the mechanical systems, such as motors and piping.
Plumbing Plans: Engineered drawings that show the layout for the plumbing system.
Roof Plan: A drawing of the view of the roof from above the building.
Scale: the ratio between the size of a drawing on an object and the size of the actual object.
Schematic: A one-line drawing showing the flow path for electrical circuitry.
Section drawing: A cross-sectional view of a specific location, showing the inside of an object or building.
Specifications: Precise written presentation of the details of a plan.
Symbol: A drawing that represents a material or component on a plan.
Title block: A part of a drawing sheet that includes some general information about the project.

Unit 16- Quality Operations- to be completed after training

Unit 17- Diagnostics and Production Processes-to be completed after training

Unit 18- Health, Safety, and Environmental Management

Combustible: capable of easily igniting and rapidly burning; used to describe a fuel with a flashpoint at or above 100°F.
Competent person: a person who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them.
Confined space: a work area large enough for a person to work but arranged in such a way that an employee must physically enter the space to perform work. A confined space has a limited or

restricted means of entry and exit. It is not designed for continuous work. Tanks, vessels, silos, pits, vaults, and hoppers are examples of confined spaces.
Excavation: any man-made cut, cavity, trench, or depression in an earth surface, formed by removing earth. It can be made for anything from basements to highways.
Extension ladder: a ladder made of two straight ladders that are connected so that the overall length can be adjusted.
Flammable: capable of easily igniting and rapidly burning; used to describe a fuel with a flashpoint below 100°F.
Flashback: a welding flame that flares up and chars the hose at or near the torch connection; caused by improperly mixed fuel.
Flash burn: the damage that can be done to eyes after even brief exposure to ultraviolet light form arc welding; requires medical attention.
Flash goggles: eye protection worn during welding operations.
Flash point: the temperature at which fuel gives off enough gases (vapors) to burn.
Ground fault circuit interrupter (GFCI): a device that interrupts and de-energizes an electrical circuit to protect a person from electrocution.
Hazard Communication Standard (HazCom): the Occupational Safety and Health Administration standard that requires contractors to educate employees about hazardous chemicals on the job site and how to work with them safely.
Lockout/tagout: a formal procedure for taking equipment out of service and ensuring that it cannot be operated until a qualified person has removed the lockout or tagout device (such as a lock or warning tag).
Material safety data sheet (MSDS): a document that must accompany any hazardous substance. The MSDS identifies the substance and gives the exposure limits, the physical and chemical characteristics, the kind of hazard it presents, precautions for safe handling and use, and specific control measures.
Occupational Safety and Health Administration (OSHA): an agency of the U.S. Department of Labor; also refers to the Occupational and Safety and Health Act of 1970, a law that applies to more than 111 million workers and 7 million job sites in the country.
Permit-required confined spaces: a confined space that has been evaluated and found to have actual or potential hazards, such as a toxic atmosphere or other serious safety or health hazard. Workers need written authorization to enter a permit-required confined space.
Personal protective equipment (PPE): equipment or clothing designed to prevent or reduce injuries.
Proximity work: work done near a hazard while not actually in contact with the hazard.
Qualified person: a person who, by possession of a recognized degree, certificate, or professional standing, or by extensive knowledge, training, and experience, has demonstrated the ability to solve or prevent problems relating to a certain subject, work, or project.
Respirator: a device that provides clean, filtered air for breathing, regardless of what is in the surrounding air.
Scaffold: an elevated platform for workers and materials.
Shoring: using pieces of timber, usually in a diagonal position, to hold a wall in place temporarily.
Signaler: a person who is responsible for directing a vehicle when the driver's vision is blocked in any way.

Six-foot rule: a rule stating that platforms or work surfaces with unprotected sides or edges that are six feet or higher than the ground or level below it require fall protection.
Stepladder: a self-supporting ladder consisting of two elements hinged at the top.
Straight ladder: a nonadjustable ladder.
Trench: a narrow excavation made below the surface of the ground that is generally deeper that it is wide, with a maximum width of 15 feet.
Welding shield: (1) a protective screen set up around a welding operation designed to safeguard workers not directly involved in that operation; (2) a shield that provides eye and face protection for welders by either connecting to helmet-like headgear or attaching directly to a hard hat; also called a welding helmet.

Unit 19: Oral and Written Communication

Active listening: a process that involves respecting others, listening to wheat is being said, and understanding what is being said.
Appendix: A source of detailed or specific information placed at the end of a section, a chapter, or a book.
Body Language: A person's physical posture and gestures that reflect how that person is feeling.
Bullets: Large, vertically aligned dots that highlight items in a list.
Electronic signature: A signature that is used to sign electronic documents by capturing handwritten signatures through computer technology and attaching them to the document or file.
Font: The type style used for printed letters and numbers.
Glossary: An alphabetical list of terms and definitions.
Graph: Information shown as a picture or chart. Graphs may be represented in various forms, including line graphs and bar charts.
Index: An alphabetical list of topics, along with the page numbers where each topic appears.
Italics: Letters and numbers that lean to the right rather than stand straight up.
Jargon: Specialized terms used in a specific industry.
Memo: Informal written correspondence. Another term form memorandum (plural: memoranda).
Permit: A legal document that allows a task to be undertaken.
Punch list: A written list that identifies deficiencies requiring correction at completion.
Table: A way to present important text and numbers to they can be read and understood at a glance.
Table of contents: A list of book chapters or sections, usually located at the front of the book.
Text message: A short message (160 characters or fewer) sent from a cell phone.

Unit 20- Application of Scientific Method, Mathematical Operations

Acute angle: Any angle between 0 degrees and 90 degrees.
Angle: The shape made by two straight lines coming together at a point. The space between those two lines is measured in degrees.
Area: The surface or amount of space occupied by a two-dimensional object such as a rectangle, circle, or square. To calculate the area for rectangles and squares, multiply the length and width. To calculate the area for circles, multiply the radius squared and pi.

Bisect: To divide into equal parts.
Circumference: The distance around the curved line the forms a circle.
Decimal: Part of a number represented by digits to the right of a point, called a decimal point. For example, in the number 1.25, .25 is the decimal part of the number.
Denominator: The part of a fraction below the dividing line. For example the 2 in ½ is the denominator.
Diameter: The length of a straight line that crosses from one side of a circle, through the center point, to a point on the opposite side. The diameter is the longest straight line you can draw inside a circle.
Equivalent fractions: Fractions having different numerators and denominators, but equal values, such as ½ and 2/4.
Formula: A mathematical process used to solve a problem. For example, the formula for finding the area of a rectangle is side A times side B =Area, or A x B = Area.
Fraction: A number represented by a numerator and a denominator, such as ½.
Improper Fraction: A fraction whose numerator is larger than its denominator. For example, 8/4 and 6/3 are improper fractions.
Mixed number: A combination of a whole number with a fraction or decimal. Examples of mixed numbers are 3-7/16, 5.75, and 1-1/4.
Numerator: The part of the fraction above the dividing line. For example the 1 in ½ is the numerator.
Obtuse angle: Any angle between 90 degrees and 180 degrees.
Percent: Of or out of one hundred. For example, 8 is 8 percent (%) of 100.
Place Value: the exact quantity of a digit, determined by its place within the whole number or by its place within the whole number or by its relationship to the decimal point.
Quotient: the result of a division. For example, when dividing 6 by 2, the quotient is 3.
Rectangle: A four-sided shape with four 90-degree angles. Opposite sides of a rectangle are always parallel and the same length. Adjacent sides are perpendicular and are not equal in length.
Remainder: The leftover amount in a division problem. For example, in the problem 34 ÷ 8, 8 goes into 34 four times (8 x 4 = 32) and 2 is left over; in other words, it is the remainder.
Square: (1) A special type of rectangle with four equal sides and four 90-degree angles. (2) The product of a number multiplied by itself. For example, 25 is the square of 5; 16 is the square of 4.
Sum: The total in an addition problem. For example, in the problem 7 + 8 = 15, 15 is the sum.
Triangle: A closed shape that has three sides and three angles.
Vertex: A point at which two or more lines or curves come together.
Volume: The amount of space occupied in three dimensions (length, width, and height/depth/thickness).
Whole numbers: Complete units without fractions or decimals.

Appendix C: Industry Standards[1]

Energy Industry Standards

Crosswalk for Energy Technology											
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
21st Century Standards											
EI 1			X						X	X	X
EI 2				X				X			
EI 3					X						
EI 4						X					
EI 5							X				
EI 6		X						X			
EI 7									X		X
EI 8								X	X		
EI 9		X						X	X		
EI 10								X	X		
EI 11					X			X	X	X	X
EI 12										X	X
EI 13								X	X		
AE 1					X			X	X	X	X
AE 2					X				X	X	X
AE 3					X					X	
AE 4					X					X	
AE 5					X					X	
ET 1											
ET 2		X						X	X		
ET 3										X	
ET 4								X			
ET 5									X		
ET 6											
ET 7											
ET 8											
ET 9											
ET 10				X				X			
ET 11		X						X			
ET 12											
ET 13											
ET 14								X			
ET 15			X					X	X		
Energy Technology											
		Unit 11	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**	**Unit 20**
EI 1		X	X	X	X						
EI 2						X			X		
EI 3					X						
EI 4					X						
EI 5					X						
EI 6					X						
EI 7		X	X	X							
EI 8							X				
EI 9											

[1]The Energy Technology Pathway Content Standards and Performance Elements are adapted from *Center for Energy and Workforce Development and the Florida Department of Education Energy Cluster.* Reprinted with permission from the Center for Energy and Workforce Development701 Pennsylvania, Ave., N.W. Washington, D.C. 20004-2696.

EI 10						X	X			X	X
EI 11			X								
EI 12											
EI 13											
AE 1		X	X	X			X				
AE 2											
AE 3		X									
AE 4			X								
AE 5				X							
ET 1		X									
ET 2							X				
ET 3			X								
ET 4											
ET 5											
ET 6					X						
ET 7					X	X	X	X			
ET 8						X				X	
ET 9						X		X			
ET 10						X	X		X		
ET 11								X	X	X	X
ET 12										X	
ET 13						X	X			X	X
ET 14						X				X	X
ET 15				X			X	X	X	X	X

EI-ENERGY INDUSTRY FUNDAMENTALS
AE-ALTERNATIVE ENERGY
ET-ENERGY GENERATION TECHNICIAN

Energy Industry Standards

After successfully completing this program, the student will be able to perform the following:

EI 1.0 Demonstrate knowledge of the basic and emerging principles and concepts that impact the energy industry.
EI 2.0 Apply compliance with procedures necessary to ensure a safe and healthy work environment.
EI 3.0 Understand electric power generation.
EI 4.0 Understand electric power transmission.
EI 5.0 Understand electric power distribution
EI 6.0 Identify and describe careers and entry requirements.
EI 7.0 Evaluate and analyze energy 'hot topics'.
EI 8.0 Describe the roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment.
EI 9.0 Explain the importance of employability and entrepreneurship skills.
EI 10.0 Use information technology tools.
EI 11.0 Discuss the value of alternative energy.
EI 12.0 Investigate the viability of biomass and biofuel.
EI 13.0 Describe the importance of professional ethics and legal responsibilities.

ALTERNATIVE ENERGY

AE1.0 Alternative Energy

AE2.0 Biomass and Biofuels
AE3.0 Nuclear Power
AE4.0 Solar Power
AE5.0 Wind Power

ENERGY GENERATION TECHNICIAN

ET 1.0	Investigate the use of nuclear power.
ET 2.0	Demonstrate leadership and teamwork skills needed to accomplish team goals and objectives.
ET 3.0	Investigate the viability of solar energy.
ET 4.0	Demonstrate personal money-management concepts, procedures, and strategies.
ET 5.0	Investigate the viability of wind energy.
ET 6.0	Understand generation system overview.
ET 7.0	Apply equipment operation, maintenance and repair.
ET 8.0	Demonstrates the ability to design, analyze and effectively use systems, components and methods with a framework of quality and continuous improvement.
ET 9.0	Diagnoses and corrects abnormalities and malfunctions in equipment and production processes.
ET 10.0	Demonstrate the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance.
ET 11.0	Use oral and written communication skills in creating, expressing and interpreting information and ideas.
ET 12.0	Demonstrate language arts knowledge and skills.
ET 13.0	Demonstrate science knowledge and skills.
ET 14.0	Demonstrate mathematics knowledge and skills.
ET 15.0	Solve problems using critical thinking skills, creativity and innovation.

Appendix D: 21st Century Skills[2]

21st Century Crosswalk for Energy Technology											
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**
21st Century Standards											
CS1			X							X	
CS2								X	X		
CS3			X					X	X		
CS4				X							X
CS5			X	X	X	X		X		X	
CS6								X			X
CS7				X			X	X	X	X	
CS8				X			X	X	X		
CS9			X					X		X	
CS10											
CS11											
CS12								X			
CS13								X			
CS14								X			
CS15								X			
CS16								X			
		Unit 12	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**	**Unit 20**	
CS1		X		X	X						
CS2											
CS3					X		X				
CS4						X			X		
CS5		X	X	X	X		X	X	X		
CS6				X		X				X	
CS7		X	X	X	X		X	X	X	X	
CS8		X	X							X	
CS9		X	X	X				X		X	
CS10										X	
CS11						X				X	
CS12										X	
CS13										X	
CS14		X						X		X	
CS15								X		X	
CS16								X	X	X	

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society

[2] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix E: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)											
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
Common Core Standards											
RL.11.1.									X	X	
RL.11.2.			X	X	X	X				X	X
RL.11.3.											
RL.11.4.											
RL.11.5.											
RL.11.6.											
RL.11.7.											
RL.11.8.											
RL.11.9.											
RL.11.10.											
RI.11.1.						X			X	X	
RI.11.2.						X			X	X	
RI.11.3.						X			X	X	
RI.11.4.		X	X	X	X	X	X	X	X	X	X
RI.11.5.											
RI.11.6.											
RI.11.7.		X	X	X	X	X	X	X	X	X	X
RI.11.8.						X		X		X	
RI.11.9.										X	
RI.11.10.											
W.11.1.								X	X	X	
W.11.2.						X		X	X	X	
W.11.3.								X			
W.11.4.		X	X	X	X	X	X	X	X	X	X
W.11.5.		X	X	X	X	X	X	X	X	X	X
W.11.6.								X			
W.11.7.								X	X	X	
W.11.8.		X	X	X	X	X	X	X	X	X	X
W.11.9.		X	X	X	X	X	X	X	X	X	X
W.11.10.		X	X	X	X	X	X	X	X	X	X
SL.11.1.		X	X	X	X	X	X	X	X	X	X
SL.11.2.		X	X	X	X	X	X	X	X	X	X
SL.11.3.									X		
SL.11.4.								X			
SL.11.5.								X	X		
SL.11.6.									X		
L.11.1.		X	X	X	X	X	X	X	X	X	X
L.11.2.		X	X	X	X	X	X	X	X	X	X
L.11.3.									X		
L.11.4.						X		X	X	X	
L.11.5.											
L.11.6.		X	X	X	X	X	X	X	X	X	X
RH.11.1.								X	X		
RH.11.2.						X		X	X	X	X
RH.11.3.						X					
RH.11.4.								X		X	X
RH.11.5.									X		
RH.11.6.											
RH.11.7.						X		X		X	X
RH.11.8.		X	X	X	X	X	X	X	X	X	X
RH.11.9.		X	X	X	X	X	X	X	X	X	X
RH.11.10.											
RST.11.1.						X		X			
RST.11.2.		X	X	X	X	X	X	X	X	X	X
RST.11.3.						X				X	X

RST.11.4.		X	X	X	X	X	X	X	X	X	X
RST.11.5.						X				X	X
RST.11.6.										X	X
RST.11.7.		X	X	X	X	X	X	X	X	X	X
RST.11.8.											
RST.11.9.		X	X	X	X	X	X	X	X	X	X
RST.11.10.		X	X	X	X	X	X	X	X	X	X
WHST.11.1.						X		X	X	X	X
WHST.11.2.								X	X		
WHST.11.3.											
WHST.11.4.								X	X		
WHST.11.5.		X	X	X	X	X	X	X	X	X	X
WHST.11.6.											
WHST.11.7.								X	X	X	X
WHST.11.8.		X	X	X	X	X	X	X	X	X	X
WHST.11.9.		X	X	X	X	X	X	X	X	X	X
WHST.11.10.		X	X	X	X	X	X	X	X	X	X
	Units	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**	**Unit 20**
Common Core Standards											
RL.11.1.										X	
RL.11.2.		X	X							X	
RL.11.3.											
RL.11.4.											
RL.11.5.											
RL.11.6.											
RL.11.7.											
RL.11.8.											
RL.11.9.											
RL.11.10.											
RI.11.1.										X	
RI.11.2.		X	X						X	X	
RI.11.3.		X	X							X	
RI.11.4.		X	X	X	X	X	X	X	X	X	X
RI.11.5.										X	
RI.11.6.											
RI.11.7.		X	X	X	X	X	X	X	X	X	X
RI.11.8.		X	X						X	X	
RI.11.9.											
RI.11.10.											
W.11.1.		X	X							X	
W.11.2.		X	X						X	X	
W.11.3.											
W.11.4.		X	X	X	X	X	X	X	X	X	X
W.11.5.		X	X	X	X	X	X	X	X	X	X
W.11.6.										X	
W.11.7.		X	X							X	
W.11.8.		X	X	X	X	X	X	X	X	X	X
W.11.9.		X	X							X	X
W.11.10.		X	X	X	X	X	X	X	X	X	X
SL.11.1.		X	X	X	X	X	X	X	X	X	X
SL.11.2.		X	X	X	X	X	X	X	X	X	X
SL.11.3.										X	
SL.11.4.		X	X						X	X	
SL.11.5.										X	
SL.11.6.										X	
L.11.1.		X	X	X	X	X	X	X	X	X	X
L.11.2.		X	X	X	X	X	X	X	X	X	X
L.11.3.										X	
L.11.4.		X	X	X	X	X	X	X	X	X	X
L.11.5.										X	
L.11.6.		X	X	X	X	X	X	X	X	X	X
RH.11.1.		X	X							X	

RH.11.2.		X	X	X	X	X	X	X	X	X	X
RH.11.3.		X	X	X	X	X	X	X	X	X	X
RH.11.4.		X	X	X	X	X	X	X	X	X	X
RH.11.5.										X	
RH.11.6.				X							
RH.11.7.		X	X	X	X	X	X	X	X	X	X
RH.11.8.											
RH.11.9.										X	
RH.11.10.		X	X	X	X	X	X	X	X	X	X
RST.11.1.										X	
RST.11.2.		X	X	X	X	X	X	X	X	X	X
RST.11.3.					X	X					
RST.11.4.		X	X	X	X	X	X	X		X	X
RST.11.5.										X	
RST.11.6.		X	X								
RST.11.7.		X	X	X	X	X	X	X	X	X	X
RST.11.8.					X	X					
RST.11.9.		X	X	X	X	X	X	X	X	X	X
RST.11.10.		X	X	X	X	X	X	X	X	X	X
WHST.11.1.		X	X		X					X	
WHST.11.2.		X	X	X	X					X	
WHST.11.3.											
WHST.11.4.		X	X						X	X	
WHST.11.5.		X	X	X	X	X	X	X	X	X	X
WHST.11.6.										X	
WHST.11.7.		X	X	X						X	
WHST.11.8.		X	X	X	X	X	X	X	X	X	X
WHST.11.9.		X	X	X	X	X	X	X	X	X	X
WHST.11.10.		X	X	X	X	X	X	X	X	X	X

Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *Reading Literature*

Key Ideas and Details

RL.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2. Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3. Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4. Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5. Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6. Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7. Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8. (Not applicable to literature)

RL.11.9. Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10. By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

Key Ideas and Details

RI.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.11.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

RI.11.3. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RI.11.5. Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

RI.11.6. Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RI.11.8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

RI.11.9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10. By the end of grade 11, read and comprehend literary nonfiction in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

W.11.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

W.11.3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

a. Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters

c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12 on page 54.)

W.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

W.11.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

a. Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

b. Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

SL.11.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

b. Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

Knowledge of Language

L.11.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

a. Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.
b. Analyze nuances in the meaning of words with similar denotations.

L.11.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas

RH.11.3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain

Craft and Structure

RH.11.4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11.5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11.6. Evaluate authors' differing points of view on the same historical event or issue by assessing the
authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas

RH.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity

RH.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

RST.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole;

include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

WHST.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each

source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

WHST.11.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Common Core Crosswalk for Mathematics (11-12)

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
N-RN.1.											
N-RN.2.											
N-RN.3.											
N-Q.1.			X		X			X			
N-Q.2.			X		X			X			
N-Q.3.			X		X			X			
N-CN.1.											
N-CN.2.											
N-CN.3.											
N-CN.4.											
N-CN.5.											
N-CN.6.											
N-CN.7.											
N-CN.8.											
N-CN.9.											
N-VM.1.											
N-VM.2.											
N-VM.3.											
N-VM.4.											
N-VM.5.											
N-VM.6.											
N-VM.7.											
N-VM.8.											
N-VM.9.											
N-VM.10.											
N-VM.11.											
N-VM.12.											
A-SSE.1.								X			
A-SSE.2.											
A-SSE.3.											
A-SSE.4.											
A-APR.1.			X								
A-APR.2.											
A-APR.3.											
A-APR.4.											
A-APR.5.											
A-APR.6.											
A-APR.7.			X								
A-CED.1.			X		X						
A-CED.2.											
A-CED.3.			X								
A-CED.4.			X								
A-REI.1.			X		X						
A-REI.2.			X								
A-REI.3.											
A-REI.4.											
A-REI.5											
A-REI.6.											
A-REI.7.											
A-REI.8.											
A-REI.9.											
A-REI.10.											
A-REI.11.											
A-REI.12.											
F-IF.1.			X								
F-IF.2.			X		X						
F-IF.3.											

F-IF.4.					X						
F-IF.5.			X		X						
F-IF.6.			X								
F-IF.7.											
F-IF.8.											
F-IF.9.											
F.BF.1.			X		X						
F.BF.2											
F.BF.3.											
F-BF.4.			X								
F-LE.1.			X								
F-LE.2.			X								
F-LE.3.											
F-LE.4.											
F-LE.5.											
F-TF.1.											
F-TF.2.											
F-TF.3.											
F-TF.4.											
F-TF.5.											
F-TF.6.											
F-TF.7.											
F-TF.8.											
F-TF.9.											
G-CO.1.											
G-CO.2.											
G-CO.3.											
G-CO.4.											
G-CO.5.											
G-CO.6.											
G-CO.7.											
G-CO.8.											
G-CO.9.											
G-CO.10.											
G-CO.11.											
G-CO.12.											
G-CO.13.											
G-SRT.1.											
G-SRT.2.											
G-SRT.3.											
G-SRT.4.											
G-SRT.5.											
G-SRT.6.											
G-SRT.7.											
G-SRT.8.											
G-SRT.9.											
G-SRT.10.											
G-SRT.11.											
G-C.1.											
G-C.2.											
G-C.3.											
G-C.4.											
G-C.5.											
G-GPE.1.											
G-GPE.2.											
G-GPE.3.											
G-GPE.4.											
G-GPE.5.											
G-GPE.6.											
G-GPE.7.											
G-GMD.1.											
G-GMD.2.											
G-GMD.3.											
G-GMD.4.											
G-MG.1.											

G-MG.2.											
G-MG.3.											
S-ID.1.											
S-ID.2.											
S-ID.3.											
S-ID.4.											
S-ID.5.											
S-ID.6.											
S-ID.7.											
S-ID.8.											
S-ID.9.											
S-IC.1.											
S-IC.2.											
S-IC.3.											
S-IC.4.											
S-IC.5.											
S-IC.6.											
S-CP.1.											
S-CP.2											
S-CP.3.											
S-CP.4.											
S-CP.5.											
S-CP.6.											
S-CP.7.											
S-CP.8.											
S-CP.9.											
S-MD.1.											
S-MD.2.											
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	Units	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**	**Unit 20**
N-RN.1.											
N-RN.2.											
N-RN.3.											
N-Q.1.					X	X					X
N-Q.2.					X	X				X	X
N-Q.3.					X	X				X	X
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A-SSE.1.						X					
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A-SSE.3.											
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A-APR.1.											
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A-CED.1.						X					X
A-CED.2.											X
A-CED.3.											X
A-CED.4.											X
A-REI.1.					X						X
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F-IF.3.											X
F-IF.4.						X				X	X
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F.BF.1.					X	X					X
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F.BF.3.						X					
F-BF.4.											X
F-LE.1.											X
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G-SRT.1.											
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G-C.1.											
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G-GPE.6.											X
G-GPE.7.											
G-GMD.1.											
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G-GMD.3.											X
G-GMD.4.											
G-MG.1.											
G-MG.2.											
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S-ID.2.						X					
S-ID.3.						X				X	
S-ID.4.											
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S-IC.1.										X	
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Mathematics (High School)

Number and Quantity

The Real Number System

N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

N-RN.2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

N-RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Quantities

N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.

N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

The Complex Number System

N-CN.1. Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + bi with a and b real.

N-CN.2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for

computation. For example, $(-1 + \sqrt{3}\, i)3 = 8$ because $(-1 + \sqrt{3}\, i)$ has modulus 2 and argument 120°.

N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

N-CN.7. Solve quadratic equations with real coefficients that have complex solutions.

N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite $x2+ 4$ as $(x + 2i)(x – 2i)$.

N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Vector and Matrix Quantities

N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|,||v||, v).

N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

N-VM.4. (+) Add and subtract vectors

N-VM.4.a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

N-VM.4.c. Understand vector subtraction $v – w$ as $v + (–w)$, where $–w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N-VM.5. (+) Multiply a vector by a scalar.

N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(vx, vy) = (cvx, cvy)$.

N-VM.5.b. Compute the magnitude of a scalar multiple cv using $||cv|| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties

N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12. (+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Seeing structure in expressions

A-SSE.1. Interpret expressions that represent a quantity in terms of its context.

A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.1.b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

Arithmetic with Polynomials and Rational Expressions

A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials

A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships.

A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of (x+ y)n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x)in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Creating Equations

A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V =IR to highlight resistance R.

Reasoning with Equations and Inequalities

A-REI.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4. Solve quadratic equations in one variable.

A-REI.4.a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)2= q$ that has the same solutions. Derive the quadratic formula from this form.

A-REI.4.b. Solve quadratic equations by inspection (e.g., for $x2= 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x2+y2= 3.

A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.12.Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Interpreting Functions

F-IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F-IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.

F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts;

intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F-IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a
factory, then the positive integers would be an appropriate domain for the function.

F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

> F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
>
> F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
>
> F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
>
> F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
>
> F-IF.7.e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

> F-IF.8.a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
>
> F-IF.8.b. Use the properties of exponents to interpret expressions for exponential functions.

F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Building Functions

F-BF.1. Write a function that describes a relationship between two quantities.

F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.1.b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.1.c. (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4. Find inverse functions.

F-BF.4.a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.

F-BF.4.b. (+) Verify by composition that one function is the inverse of another.

F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

F-BF.4.d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Linear, Quadratic, and Exponential Models

F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F-LE.4. For exponential models, express as a logarithm the solution to ab ct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.

Trigonometric Functions

F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.

F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.

F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.

F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Congruence

G-CO.1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

G-CO.6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

G-CO.9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Similarity, Right Triangles, and Trigonometry

G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

G-SRT.1.a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

G-SRT.1.b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

G-SRT.4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

G-SRT.6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7. Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

G-SRT.9. (+) Derive the formula $A = 1/2\ ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Circles

G-C.1. Prove that all circles are similar.

G-C.2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.

G-C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Expressing Geometric Properties with Equations

G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2. Derive the equation of a parabola given a focus and directrix.

G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

G-GPE.4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Geometric Measurement and Dimension

G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

G-GMD.4. Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry

G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Statistics and Probability

Interpreting Categorical and Quantitative Data

S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).

S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.
Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

S-ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S-ID.6.a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.

S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.

S-ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S-ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

S-ID.9. Distinguish between correlation and causation.

Making Inferences and Justifying Conclusions

S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC.6. Evaluate reports based on data.

Conditional Probability and the Rules of Probability

S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).

S-CP.2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

S-CP.3. Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

S-CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly

selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

S-CP.6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.

S-CP.7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.

S-CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

S-MD.1.(+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

S-MD.3.(+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?

S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

> S-MD.5.a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.

S-MD.5.b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Appendix F: National Educational Technology Standards for Students (NETS-S)

NETS Crosswalk for Energy Technology											
	Course	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
NETS Standards											
T1									X		
T2		X		X				X	X	X	
T3				X	X	X	X	X	X	X	X
T4			X	X					X		
T5		X		X				X	X		
T6									X		
		Unit 11	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**	**Unit 17**	**Unit 18**	**Unit 19**	**Unit 20**
T1										X	X
T2		X	X					X	X		X
T3		X	X		X	X	X			X	X
T4		X	X			X	X		X	X	X
T5						X	X				X
T6				X		X	X	X	X	X	X

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.