



# Energy Industry Competency Model

**Generation  
Transmission &  
Distribution**

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**Center for Energy Workforce Development**

# Executive Summary

**W**ith the growth and speed of changes in technology, the energy industry needs a workforce with the knowledge and skills for traditional energy production and delivery, as well as developing capabilities for the future.

The message for workforce development is clear: qualified and skilled utility technicians will continue to be in high demand in all types of energy generation, transmission and distribution jobs. Moreover, the foundational skills needed by this generation of new workers are the same, whether the job is ultimately in a plant, on a transmission line or in a trench. Students who want to work in the energy industry will be well served to focus on gaining core foundational skills that are transferable and applicable to a wide array of skilled technician jobs.

Adding to the workforce now provides the opportunity for experienced workers to transfer their knowledge and skills, before they leave the industry. To accomplish this knowledge transition, potential candidates must understand the industry and the skills and competencies required to perform critical energy jobs.

These issues drove the development within CEWD of an energy competency model that can be used by educators, workforce investment professionals, and utilities and their contractor partners to articulate the skills required to perform the work. Working from a foundation of core competencies enables companies to screen candidates more effectively and then focus on training that is only unique to the organization.

A competency model is a collection of competencies that together define the potential for successful performance in a particular work setting. Competency models are the foundation for important human resource functions—such as recruitment and hiring, training and development, retention and performance management—because they specifically define what is essential to select as well as train and develop a diverse, talented candidate pool.

## **WHY A COMPETENCY MODEL?**

The Energy Industry Competency Building Block model is designed to provide a consistent definition of the competencies required to work in the industry. The model builds from basic fundamentals to more industry and career specific competencies.

The Competency Model consists of stacked tiers increasing in specificity and specialization as the pyramid ascends. Each tier is divided into blocks representing content or the skills, knowledge, abilities and other factors that are essential to successful performance in the industry. Not all competencies are required for all of the jobs in the energy business; for example, all competencies on the lower tiers are not necessarily needed to achieve the competencies needed on upper level tiers.

The competencies reflected at the base of the model (Tiers 1 – 3) represent those needed for success in life and in the foundation for success in school and work. These foundational skills are a needed prerequisite for workers to be able to learn new industry-specific skills.

### HOW SHOULD THE MODEL BE USED?

The Competency Building Block model is intended to help educators, students, Career One Stops and potential employees understand the competencies required to work in the energy industry. The model can be used by educators and Career One Stop locations to tailor curriculum to reinforce the competencies. Students can use the model to match job requirements as identified by employers with their skills. Where there are gaps, short-term training programs can be developed to address them or existing programs can be modified.



### HOW ARE THESE COMPETENCIES USED IN THE WAREHOUSE?

One of the difficulties that students have when taking math, English or science courses is understanding how the course relates to the real world and the jobs that they wish to pursue. Computer skills, problem solving and decision making are key requirements in energy jobs.

- **Algebra** – increases problem solving skills which are needed when troubleshooting problems in a power plant station, substation or on a power line.
- **Geometry** – using diagrams to install new equipment or wiring which requires measuring and understanding dimensions and space.
- **Physics** – understanding the basic concepts of physics such as electrons and protons helps in understanding how electricity is generated, moved along power lines, stepped down in voltage and distributed to customers.
- **History/Humanities/Social Sciences** – understanding the experiences of other cultures helps in teamwork, collaboration and problem solving.
- **English** – being able to speak, write and read English helps the individual follow directions, ensure a safe job site, prepare reports and talk to the boss, coworkers, and customers.

# ENERGY INDUSTRY COMPETENCY MODEL GRAPHIC



## FRAMEWORK OF COMPETENCIES FOR THE ENERGY GENERATION, TRANSMISSION AND DISTRIBUTION INDUSTRY

### Tier 1: Personal Effectiveness

#### PERSONAL EFFECTIVENESS

##### 1. Interpersonal Skills: Displaying skills to work with people

- Demonstrates concern for others by being sensitive to their needs and feelings
- Shows understanding of others behavior by demonstrating appropriate responses
- Demonstrates respect for the opinions, perspectives, customs and individual differences of others by including others in problem solving and decision making
- Maintains open communication with others
- Recognizes and accurately interprets the verbal and nonverbal behaviors of others
- Demonstrates flexibility and open mindedness when dealing with a wide range of people
- Listens to and considers others' viewpoints and alters own opinion when it is appropriate

##### 2. Integrity: Displaying accepted social and work behaviors

- Treats all in a fair and equitable manner
- Behaves ethically through responsible use of company time and property
- Reports unethical behavior demonstrated by others

##### 3. Professionalism: Maintaining a professional presence and adhering to ethical standards

- Demonstrates self-control by maintaining composure and keeping emotions in check even in difficult situations
- Maintains a professional appearance by dressing appropriately for the job and maintaining personal hygiene
- Uses professional language when speaking with others
- Maintains a positive attitude
- Takes pride in one's work and the work of the organization



##### 4. Reputation: Maintaining a high degree of personal ethics and behaviors

- Is free from substance abuse
- Demonstrates financial responsibility
- Maintains an acceptable grade point average in school
- Has not embarrassed oneself through internet postings
- Maintains a good driving record

##### 5. Motivation: Demonstrating a commitment to effective job performance

- Ensures that job is done safely, accurately and completely
- Identifies new and better processes or procedures
- Follows instructions and direction from others
- Takes responsibility for completing one's own work assignment

##### 6. Dependability/Reliability: Displaying responsible behaviors at work

- Comes to work when scheduled and on-time
- Complies with company policies
- Does not attend to personal business while on the job
- Manages stressful situations effectively
- Fulfills obligations of the job

##### 7. Self-Development: Demonstrating a commitment to self development and improvement

- Identifies goals and career interests
- Demonstrates an interest in learning
- Seeks opportunities to learn new skills and tasks and to refine current skills

- Adapts quickly to changes in process or technology
- Accepts help from others

### **8. Flexibility & Adaptability: Adjusting to changing work requirements**

- Adjusts to changing priorities
- Identifies logical stopping points in work
- Refocuses attention to new assignment quickly
- Quickly learns new assignments
- Shifts gears and changes direction when working on multiple projects
- Anticipates and accepts changes in work

### **9. Ability to Learn: Incorporating classroom and on the job training into work performance**

- Understands and uses material taught in the classroom and on the job training in work situations
- Applies information provided in training to work tasks
- Desires and shows willingness to learn new assignments, procedures and technologies

## **Tier 2: Academic Requirements**

### **ACADEMIC COMPETENCIES**

#### **1. Mathematics: Using mathematics to solve problems**

- Adds, subtracts, multiplies and divides with whole numbers, fractions, decimals and percents; calculates averages, ratios, proportions and rates
- Reads and understands tables and graphs
- Takes measurement of time, temperature, distance, length, width, height, perimeter, etc
- Correctly converts from one measurement to another
- Translates practical problems into useful mathematical expressions and uses appropriate mathematical formulas and techniques
- Solves simple algebraic equations
- Is able to determine slope, midpoint and distance
- Calculates perimeters, areas and volumes of basic shapes and solids
- Reads, tracks and calculates gauge measurements

#### **2. Locating, Reading and Using Information: Knowing how to find information and identifying essential information**

- Is able to read and understand written material
- Sorts through distracting information
- Scans written material for subject of interest
- Is able to identify main ideas in written material
- Correctly interprets written material
- Integrates what is learned from written materials with prior knowledge
- Applies what is learned from the written material to complete specific tasks

#### **3. Writing: Using standard business English to write messages to co-workers and reports to managers and associates**

- Creates documents such as work orders or memos
- Uses standard syntax and sentence structure, correct spelling, punctuation and capitalization and appropriate grammar
- Writes clearly and concisely in a professional and courteous manner
- Writes effectively for a variety of audiences



- Communicates thoughts, ideas and information which may contain technical material in a logical, organized and coherent manner
- Clearly develops ideas and elaborates on them with relevant supporting examples and specific details
- Shows insight, perception and depth in writing

#### **4. Listening: Listening carefully in order to incorporate information into work activities**

- Listens carefully to others
- Correctly interprets information provided by others
- Is able to incorporate information into actions

#### **5. Speaking: Communicating in spoken English well enough to be understood by supervisors, co-workers and customers**

- Uses standard sentence structure and appropriate grammar
- Speaks clearly, in precise language and in a logical organized and coherent manner
- Keeps language simple and appropriate for the audience's level of knowledge of the subject

#### **6. Engineering and Technology: Possessing an appropriate mastery of knowledge, techniques, skills, modern tools and advanced technology**

- Applies basic engineering principles
- Applies the appropriate technical solution
- Applies principles of engineering science and technology, techniques, procedures and equipment to the design and production of various goods and services
- Applies the basics of electricity
- Identifies and selects the appropriate hand or small electric tools or diagnostic equipment for the work
- Solves problems where a variety of mechanical, electrical, thermal or fluid faults could be the reason for the problem

#### **7. Science: Using scientific rules and methods to solve problems**

- Discusses the role of creativity in constructing scientific questions, methods and explanations
- Formulates scientifically investigable questions, constructs investigations, collects and evaluates data and develops scientific recommendations based on findings
- Understands physical principles such as force, friction and energy
- Understands weight and mass and how it relates to rigging, wind and structure supports
- Understands and evaluates the characteristics and hazards of electricity
- Recognizes and understands the interactions of compatible and incompatible substances
- Applies basic scientific principles and technology to solve problems and complete tasks

#### **8. Information Technology: Demonstrating basic IT skills for workplace efficiency and work flow**

- Uses Personal Information Management (PIM) applications to increase workplace efficiency
- Employs technological tools to expedite workflow including word processing, databases, reports, spreadsheets, multimedia presentations, electronic calendar, contacts, email and internet applications
- Employs computer operations applications to access, create, manage, integrate and store information
- Employs collaborative/groupware applications to facilitate group work

#### **9. Critical and Analytical Thinking: Using logical thought processes to analyze information and draw conclusions**

- Identifies inconsistent or missing information
- Critically reviews, analyzes, synthesizes, compares and interprets information
- Draws conclusions from relevant and/or missing information
- Tests possible hypotheses to ensure the problem is correctly diagnosed and the best solution is found
- Perceives and understands relationships appropriate to the task

## Tier 3: Workplace Competencies

### WORKPLACE COMPETENCIES

#### 1. Business Fundamentals: Understanding the relationship between an individual's own job and the goals and operations of company and industry

- Is able to articulate the organization's mission and functions and its position in the marketplace
- Recognizes one's role in the functioning of the company
- Complies with applicable laws and rules governing work and reports loss, waste or theft of company property to appropriate personnel
- Acts in the best interest of the company, community and environment

#### 2. Teamwork: Developing capacities used to work with others

- Accepts membership in the team
- Identifies with the goals, norms, values and customers of the team
- Uses a group approach to identify problems and develop solutions based on group consensus
- Effectively communicates with all members of the team to achieve goals
- Develops constructive and cooperative working relationships with others
- Shows sensitivity to the thoughts and opinions of others
- Responds appropriately to positive and constructive feedback
- Encourages others to express their ideas and opinions
- Learns from other team members



- Applies interpersonal skills to help team achieve goals
- Gives full attention to what others are saying, taking time to understand the points being made, asking questions as appropriate and not interrupting at inappropriate times
- Keeps all parties informed of progress and all relevant changes to project timelines
- Demonstrates loyalty to the team

#### 3. Following Directions: Receiving, understanding and carrying out assignments with minimal supervision

- Receives, interprets, understands and responds to verbal messages and other cues
- Picks out important information in verbal messages
- Interprets complex instructions and their relevance to the work assignment
- Asks questions to clarify unclear directions
- Acts upon the instruction to complete an assignment

#### 4. Planning/Organizing/Scheduling: Demonstrating the ability to work within a schedule using prescribed procedures

- Prioritizes various competing tasks and performs them quickly and efficiently according to their urgency
- Finds new ways of organizing work area or planning work to accomplish work more efficiently
- Estimates resources needed for project completion; allocates time and resources effectively
- Anticipates obstacles to project completion and develops contingency plans to address them; takes necessary corrective action when projects go off-track
- Plans and schedules tasks so that work is completed on time
- Makes arrangements that fulfill all requirements as efficiently and economically as possible
- Responds to the schedules of others affected by arrangements; informs others of arrangements, giving them complete, accurate and timely information
- Keeps track of details to ensure work is performed accurately and completely
- Takes steps to verify all arrangements; recognizes problems, generates effective alternatives and takes corrective action

- Effectively coordinates the transition of employees at the beginning and end of each work shift; disseminates crucial information in an organized manner to rapidly bring employees up to speed at the start of their shifts

#### **5. Problem Solving/Decision-Making: Applying problem-solving and critical-thinking skills to help grow the business and/or to resolve workplace conflict**

- Anticipates or recognizes the existence of a problem
- Identifies the true nature of the problem by analyzing its component parts
- Effectively uses both internal and external resources to locate and gather information; examine information obtained for relevance and completeness; recognizes important gaps in existing information and takes steps to eliminate those gaps; recalls previously learned information that is relevant to the problem; organizes information as appropriate to gain a better understanding of the problem
- Integrates previously learned and externally obtained information to generate a variety of high quality alternative approaches to the problem
- Skillfully uses logic and analysis to identify the strengths and weaknesses, the costs and benefits and the short and long-term consequences of different approaches
- Decisively chooses the best solution after contemplating available approaches to the problem; makes difficult decisions even in highly ambiguous or ill-defined situations; quickly chooses an effective solution without assistance when appropriate
- Commits to a solution in a timely manner and develops a realistic approach for implementing the chosen solution; observes and evaluates the outcomes of implementing the solution to assess the need for alternative approaches and to identify lessons learned
- Uses scientific rules and methods to solve problems

#### **6. Ethics: Describing the importance of personal ethics and legal responsibility**

- Anticipates or recognizes the existence of a problem
- Evaluates and justifies decisions based on ethical reasoning
- Evaluates alternative responses to workplace situations based on personal, professional, ethical and legal responsibilities and employer policies
- Identifies and explains personal and long-term consequences of unethical or illegal behaviors in the workplace
- Interprets and explains written organizational policies and procedures

#### **7. Employability and Entrepreneurship Skills: Defining ongoing career development**

- Identifies and demonstrates positive work behaviors needed to be employable
- Develops personal career plan that includes goals, objectives and strategies
- Examines licensing, certification and industry credentialing requirements
- Maintains a career portfolio to document knowledge, skills and experience
- Evaluates and compares employment opportunities that match career goals
- Identifies and exhibits traits for retaining employment
- Identifies opportunities and researches requirements for career advancement
- Researches the benefits of ongoing professional development
- Examines and describes entrepreneurship opportunities as a career planning option

## **8. Working with Basic Hand and Power Tools and Technology: Having capability to operate and troubleshoot electric and electronic equipment, mechanical and electrical products**

- Selects and applies appropriate tools or technological solutions to frequently encountered problems
- Carefully considers which tools or technological solutions are appropriate for a given job and consistently chooses the best tool or technological solution for the problem at hand
- Demonstrates an interest in learning about new and emerging tools and technologies; seeks out opportunities to improve knowledge of tools and technologies that may assist in streamlining work and improving productivity
- Knows how to maintain and troubleshoot tools and technologies
- Uses basic computer technology to receive work orders, report progress and maintain records

## **Tier 4: Industry-wide Technical Competencies**

### **INDUSTRY-WIDE TECHNICAL COMPETENCIES**

#### **1. Safety Awareness: Complying with the procedures necessary to ensure a safe and healthy work environment**

- Is cognizant of the environment and potential hazards
  - Follows established safety procedures
  - Evaluates changes in the environment with respect to their impact on safety of self and others
  - Promotes effective local, state or national security operations for the protection of people, data, property and institutions
  - Complies with safety procedures and proper ways to perform work
  - Understands potential threats created by deviation from safety procedures and improper use of tools and equipment
  - Follows safety procedures and uses safety equipment as specified by user manuals and safety training
  - Uses personal protection equipment including safety glasses, work boots and hard hats
- Keeps personal safety equipment in good working order
  - Uses tools and equipment in compliance with user manuals and training
  - Calls attention to potential and actual hazardous conditions as they arise
  - Alerts co-workers and supervisory personnel to hazardous conditions and deviations from safety procedures in a timely manner
  - Maintains appropriate certification and is knowledgeable in first aid or first response procedures
  - Demonstrates knowledge of lock out/tag out practices
  - Notifies person in charge and/or co-workers of unsafe work conditions
  - Stops the job if there are unsafe working conditions

#### **2. Industry Principles and Concepts: Knowing the basic and emerging principles and concepts that impact the energy industry, including: energy production, energy transmission and alternative energy technologies**

- Is able to explain the flow of energy from generation through distribution to the customer
- Is able to explain the role of regulators and unions in the industry
- Discusses the history of the United States energy industry/infrastructure (refer to Energy Information Administration - [www.eia.doe.gov](http://www.eia.doe.gov) )
- Identifies the role and function of generation, transmission and distribution organizations
- Explains the role of regulatory bodies in the energy industry (such as: Federal Energy Regulatory Commission - [www.ferc.gov](http://www.ferc.gov) ; State Public Service Commissions) highlighting the concept of "obligation to serve"
- Explains the different structures of energy companies, including investor-owned utilities, municipalities (associated utility practices such as water/wastewater), electric cooperatives, independent power producers and is able to explain the different lines of energy business, including electric and gas
- Describes the process of metering and billing for energy consumption

- Demonstrates an awareness of alternative and renewable energy technologies, including geothermal energy, solar energy, wind energy, water energy and biofuel

### **3. Environmental Laws and Regulations: Complying with relevant local, state, and federal environmental laws and regulations that impact the energy industry**

- Discusses environmental laws and regulations that impact the energy industry (local, state and federal) and explains the importance of proper documentation to ensure compliance
- Demonstrates professional responsibility for maintaining all policies and standards for health, safety and the environment
- Complies with all relevant environmental laws issued by federal agencies, including EPA
- Follows energy standards produced by industry organizations, such as ANSI, API, NACE and NFPA
- Identifies appropriate jurisdiction for local, state and federal regulatory agencies as they pertain to the energy industry
- Maintains current knowledge of regulatory procedures governing operations

### **4. Quality Control/Continuous Improvement: Demonstrating the ability to design, analyze and effectively use systems, components and methods with a framework of quality and continuous improvement**

- Conducts tests and inspections of products, services or processes to evaluate quality or performance
- Incorporates new information into both current and future problem solving and decision making
- Monitors/assesses performance of self, other individuals or organizations to make improvements or take corrective action
- Determines how a system should work and how changes in conditions, operations and the environment will affect outcomes
- Uses logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems



### **5. Troubleshooting: Diagnosing and correcting abnormalities and malfunctions in equipment and production processes**

- Monitors equipment to ensure maintenance schedules are adhered to
- Demonstrates knowledge of normal equipment operation (how the individual pieces of equipment relate to each other) in order to spot potential equipment problems before they occur
- Determines causes of operating errors, decides what to do about them and knows when to notify more senior personnel

## Tier 5: Industry-Specific Technical Competencies | Energy Generation, Transmission and Distribution

### INDUSTRY-SECTOR TECHNICAL COMPETENCIES | ENERGY GENERATION, TRANSMISSION AND DISTRIBUTION

#### 1. Non-Nuclear Generation: Technical skills and knowledge necessary for gas, oil, coal, hydro, solar, wind, biofuel or geothermal power plant personnel

##### Science and Engineering Theory and Concepts:

- Is able to define and explain the differences and similarities of power generation, including use of different fuel types (fossil fuels – gas and oil, hydro and marine, alternative fuels – solar, wind, biofuel and geothermal) and different plant uses (i.e., peaking, load following, base load)
- Is able to explain the advantages and disadvantages of alternative energy sources
- Understands the behavior of matter
- Applies direct current (DC) concepts and laws; performs calculations and measurements including the following:
  - basic electrical circuits such as series and parallel, series-parallel combinations
  - conductors and insulators
  - direct current (DC) theory and DC sources (such as ideal voltage and current, non-ideal voltage and current)
  - electrical laws (such as Ohm's law, Kirchhoff's voltage and current laws)
  - electron theory
  - units of electrical measurement (such as ohms, volts, amps, watts, coulombs, joules)
  - voltage, current, resistance and power
- Applies alternating current (AC) concepts and laws; performs calculations and measurements including the following:
  - alternating current (AC) theory and AC sources (such as ideal voltage and current, non-ideal voltage and current)
  - basic electrical circuits such as series and

parallel

- units of electrical measurement (such as henries, farads, reactance, impedance)
- passive components, capacitors and inductors
- single-phase versus three-phase
- voltage, current, impedance, real, reactive, apparent power and power factor relationships
- Has a basic knowledge of water and general chemistry

##### Basic Components Knowledge:

- Is knowledgeable of the location of equipment in the plant, how the equipment operates and normal operating parameters
- Is able to use tools such as hand tools, power tools and meters
- Describes the theory, construction and application of the mechanical components such as air compressors, heat exchangers, steam condensers, steam generators, pumps, ejectors, strainers, filters and traps, steam traps, steam turbines and valves
- Describes the theory, construction and application of diesel engines including main structural components, main moving components, principles of operations, failure mechanisms and systems and accessories and support systems
- Describes the theory, construction and application of air conditioning, heating and ventilation systems, including refrigeration machines and the basic refrigeration cycle



- Describes the theory, construction and application of structural and auxiliary equipment such as boilers, elevators, fire barriers, hangers and snubbers for support and restraint and hoists and cranes
- Describes the theory, construction and application of rotating equipment including generators, motors and motor-generators
- Describes the theory, construction and application of resistive electrical equipment including heaters and heat tracing
- Describes the theory, construction and application of electrical supply components including the following:
  - batteries and chargers
  - circuit breakers (such as protection)
  - inverters and uninterruptible power supplies
  - switchgear, load centers and motor control centers (such as protective relaying and schematics of a basic system from high voltage to lower voltage)
  - transformers (such as step-up transformers and step-down transformers)
- Describes the theory, construction and application of electrical control components including cables, control circuits, meters and relays
- Describes the theory, construction and application of valve actuator types (such as motors, pneumatic, hydraulic)
- Describes the theory and application of electronic equipment including the following:
  - analyzers (such as H<sub>2</sub>, O<sub>2</sub> and chemical)
  - signal converters
- Explains the principles associated with instrumentation and control and describes the following:
  - basic control circuits (such as proportional, integral, derivative and a combination of the three; saturation cutoff, steady-state error, limiters, effects of disturbances)
  - pneumatic devices (such as actuators)
  - sensors (such as types of sensors, for example, pressure, flow, temperature)
  - hydraulic controls (such as actuators)
- Explains bearing design and lubrication principles associated with the following:
  - determination of oil levels and requirements and addition of correct oil to plant components
  - environmental hazards
  - factors that affect lubrication
  - friction and wear
  - fluid lubrication
  - lubricant types and characteristics
  - purpose and necessity
  - storage and transfer
  - symptoms and problems associated with improper lubrication
  - safety hazards
- Explains the principles associated with thermodynamics and combustion
- Is knowledgeable of hazardous and safety procedures
- Is able to calibrate and certify tools
- Is able to plan and organize relevant materials and tools prior to job site work

#### **Computer Skills:**

- Is knowledge of procedures to access, file and use record-keeping logs
- Understands computer operation, utilizes integrated/multiple software and networks
- Is able to use Microsoft Office (or equivalent) software to prepare spreadsheets for data analysis and reports for management review and approval

## **2. Nuclear Generation: Technical skills and knowledge necessary for nuclear power plant personnel**

#### **Electrical Science:**

- Explains and uses the fundamental concepts associated with electricity (e.g., electric charge, electric current)
- Understands the components of electrical systems including switchyard construction, transformers, relays, circuit breakers and motors

### Reactor Theory and Operations:

- Explains the general design overview of the basic reactor types
- Demonstrates understanding of reactor startup and shutdown procedures
- Explains the fission process including the construction of fission product barriers

### Operations and Repair:

- Complies with the procedures necessary to ensure a safe and healthy work environment
- Operates, repairs and tests machines, devices and equipment based on electrical or mechanical principles in order to diagnose machine malfunctions
- Operates basic hand and small electric tools and equipment
- Conducts tests and inspections of products, services or processes to evaluate quality or performance
- Determines the kind of tools and equipment needed to do a job
- Watches gauges, dials or other indicators to make sure a machine is working properly
- Is able to read, interpret and create basic prints used in the design, operation and maintenance of electrical systems including engineering drawings, diagrams and schematics - documentation diagrams, single line diagrams

### Additional Academic Requirements:

- **Physics** – Explains and uses physics terms, units, definitions and basic concepts including mechanical principles (laws of motion, energy, conditions of equilibrium) and units (pressure, temperature, flow, volume)
- **Basic Atomic & Nuclear Physics** – Explains the basic atomic and nuclear physics terms, unit, definitions and basic concepts including atomic structure, nuclear interactions and reactions, sources of residual heat/decay heat and reactor operation

- **Chemistry** – Explains the chemistry terms, units, definitions and basic concepts and applies the concepts successfully on the job, including fundamentals of chemistry (molecules, mixtures, solutions and compounds, corrosion control), water chemistry control, reactor water chemistry and the corrosion process
- **Mathematics** – Has experience and knowledge in scientific notation, dimensional analysis, geometry, trigonometry, graphs and control charts, relational charts, exponents and logarithms and basic statistics

### 3. Electric Transmission and Distribution: Knowledge and skills necessary for the transmission and distribution of electricity from the generation source to the end customer

#### Science and Technology:

- Understands the components and workings of the electric transmission and distribution network
- Applies direct current (DC) concepts and laws and performs calculation and measurements including the following:
  - basic electrical circuits such as series and parallel, series-parallel combinations
  - conductors and insulators
  - direct current (DC) theory and DC sources (such as ideal voltage and current, non-ideal voltage and current)
  - electrical laws (such as Ohm's law, Kirchhoff's voltage and current laws)
  - electron theory
  - units of electrical measurement (such as ohms, volts, amps, watts, coulombs, joules)
  - voltage, current, resistance and power

- Applies alternating current (AC) concepts and laws and performs calculations and measurements including the following:
  - alternating current (AC) theory and AC sources (such as ideal voltage and current, non-ideal voltage and current)
  - basic electrical circuits such as series and parallel
  - units of electrical measurement (such as henries, farads, reactance, impedance)
  - passive components, capacitors and inductors
  - single-phase versus three-phase
  - voltage, current, impedance, real, reactive, apparent power and power factor relationships
- Understands how electrical current moves through a circuit or a system and how electricity affects a circuit or system. Understands how to control current and resistance.
- Understands the way solid things move and how leverage, force, friction and momentum affect that motion and is able to solve problems with simple machines, complex machines and mechanical systems

- Understands the way fluids (liquids and gases such as water and air) act as conductors or insulators
- Understands the movement of heat, specifically which substances warm up quickly when heated and which ones warm up more slowly
- Understands how specific heat works, including how different materials hold heat for different amounts of time
- Understands and applies tag out/lock out procedures

#### Basic Components Knowledge:

- Is knowledgeable of design techniques, tools and principles involved in production of precision technical plans, blueprints, drawings and models
- Is knowledgeable of machines and tools, including their designs, uses, repair and maintenance
- Is able to work with electrical instruments such as voltmeters, ammeters, fault locators, etc.
- Understands the application of hoists, tackle and knots used in construction and maintenance work
- Understands the interrelationships among components of systems in order to understand how such components affect each other, act together, fit together, etc.
- Is able to identify “unusual” sounds or vibrations from among competing, “normal” sounds or vibrations
- Is able to detect deviations or exceptions from normal operating conditions

#### Customer Focus:

- Interacts directly with the public listening to and understanding customer needs and determining how to address them
- Interacts with customers regarding the termination and restoration of electric service, which is required as a result of maintenance and construction work



#### **4. Gas Transmission and Distribution: Knowledge and skills necessary for the transmission and distribution of natural gas from the refinery to the end customer**

##### **Science and Technology:**

- Understands and applies the fundamental concepts of natural gas
- Understands the components and workings of the gas transmission and distribution network, including metering and regulating stations
- Applies direct current (DC) concepts and laws and performs calculation and measurements including the following:
  - basic electrical circuits such as series and parallel, series-parallel combinations
  - conductors and insulators
  - direct current (DC) theory and DC sources (such as ideal voltage and current, non-ideal voltage and current)
  - electrical laws (such as Ohm's law, Kirchhoff's voltage and current laws)
  - electron theory
  - units of electrical measurement (such as ohms, volts, amps, watts, coulombs, joules)
  - voltage, current, resistance and power
- Applies alternating current (AC) concepts and laws and performs calculations and measurements including the following:
  - alternating current (AC) theory and AC sources (such as ideal voltage and current, non-ideal voltage and current)
  - basic electrical circuits such as series and parallel
  - units of electrical measurement (such as henries, farads, reactance, impedance)
  - passive components, capacitors, inductors
  - single-phase versus three-phase
  - voltage, current, impedance, real, reactive, apparent power and power factor relationships
- Understands the way solid things move and how leverage, force, friction, and momentum affect that motion and is able to solve problems with simple machines, complex machines and mechanical systems
- Understands the way fluids (liquids and gases such as water and air) move through systems and is able to solve problems with plumbing, hydraulics or pneumatics (compressed gas)
- Understands the movement of heat, specifically which substances warm up quickly when heated and which ones warm up more slowly
- Understands how specific heat works, including how different materials hold heat for different amounts of time

##### **Basic Components Knowledge:**

- Is knowledgeable of design techniques, tools and principles involved in the production of precision technical plans, blueprints, drawings and models
- Is knowledgeable of machines and tools, including their designs, uses, repair and maintenance

##### **Customer Focus:**

- Interacts directly with the public listening to and understanding customer needs and determining how to address them
- Interacts with customers regarding the termination and restoration of gas service, which is required as a result of maintenance and construction work

## **Tier 6 Industry-Specific Job Specific Competencies | Energy Generation, Transmission and Distribution**

**NON-NUCLEAR GENERATION:** Technical skills and knowledge necessary for gas, oil, coal, hydro, solar, wind, biofuel or geothermal power plant personnel

### **PLANT OPERATORS**

#### **1. Operate and Monitor Plant Equipment**

- Is knowledgeable of standard operating procedures, documentation requirements and required logs
- Understands how plant systems interrelate and the impact of this interrelationship on plant performance
- Is knowledgeable of industry, plant, company, equipment, scientific, technical, tool, safety and personnel terminology
- Is knowledgeable of corrective actions and responses for specific problems
- Is able to read and document equipment histories and trend data
- Is knowledgeable of the types of adjustments to make on equipment and the correct quantity of adjustment
- Is able to recognize alarms and is knowledgeable of the meaning of the alarm and the associated corrective actions
- Is able to identify and report out of compliance or unsafe conditions
- Is knowledgeable of chronic problems and system malfunctions and their resolutions
- Is able to demonstrate knowledge of schematics and diagrams (mechanical, electrical, civil) and symbols
- Is knowledgeable of priorities and criticality of problems and root causes of problems
- Is able to operate project control systems such as the Digital Control System (DCS) and Supervisory Control and Data Acquisition (SCADA)
- Has a basic understanding of PLC's

#### **2. Manage Plant Systems**

- Is knowledgeable of the characteristics of fuel and the quantities required to produce a given output
- Is able to identify the levels of resource availability and to estimate amounts required to meet output requirements
- Is knowledgeable of hydraulics and travel time
- Is knowledgeable of inventory and logistics control systems and procedures
- Is knowledgeable of the impact of variable weather conditions on plant equipment operation
- Is able to identify deficiencies in resources and knowledge of reporting procedures
- Is knowledgeable of how flow and level of fuel impact one another
- Is knowledgeable of flow versus level of fuel
- Is able to make manual adjustments to plant equipment to restore or maintain system performance

#### **3. Support Equipment Maintenance**

- Is knowledgeable of the scope of work of the maintenance to be performed
- Is knowledgeable of energy isolation and how to remove all potential energy to put equipment in a safe condition such as de-energizing pressure, electrical, rotation and springs
- Is knowledgeable of lockout/tagout requirements and procedures
- Has a basic understanding of the maintenance process and procedures

### **ELECTRIC, MECHANICAL, INSTRUMENT AND CONTROL TECHNICIANS (common for all classifications)**

#### **1. Science and Engineering Theories and Concepts**

- Explains the basics of the following topics:
  - grounding systems
  - electrical hazards and safety
  - electrical power sources
- Is knowledgeable in the following foundational science and engineering concepts and theories:

- Pressure and chemistry of steam/water, boiler water, air and oil

- Gases and liquids
- Mechanical energy
- Levers, pulleys and machines
- Hydraulics and pneumatics
- Principles and causes of cavitation
- Water treatment and purification
- Friction and bearings on machines
- Hydrologic life cycles (hydro fuel delivery/ source)

## 2. Thermal Concepts

- Understands the sources of fuel and the differences in quality, composition and chemistry
- Understands the basics of processing and storing fuel

## 3. Maintain and Repair Equipment

- Is knowledgeable of and is able to perform diagnostic tests, use test equipment and interpret the output from the tests and diagnostic equipment
- Is able to access and read equipment logs and histories
- Is able to execute isolation procedures
- Is knowledgeable of the differences between prime mover equipment versus auxiliary equipment
- Is able to explain the following systems in detail:
  - auxiliary feedwater or reactor core isolation cooling
  - auxiliary steam, including boilers
  - circulating water
  - condensate, feedwater and polisher (demineralizer)
  - fire water systems, including pumps and special valves
  - instrument and station air
  - systems that contain important valves
  - thrust bearing
  - guide bearing
  - oil transport
  - potable and non-potable water
  - ventilation
  - oil filtration
  - fuel delivery
  - fire protection
  - ash removal and disposal

## MAINTENANCE AND INSTRUMENT & CONTROL (common to these classifications)

### 1. Maintain and Repair Equipment

- Explains clearance/tagging requirements
- Describes the proper methods for handling and disposing of waste or hazardous materials that result from system maintenance
- Describes component failure modes (for example, valve thermal binding and relay failures) and discusses the possible diagnostic and repair actions that may be necessary
- Describes the proper methods and practices for safe troubleshooting of defective components
- Describes the proper methods for breaching systems, including applicable radiological exposure and contamination controls
- Describes the application and operation of various devices (for example, video cameras, filter removal tools and remotely operated machines) used for radiological exposure reduction
- Describes potential hazards (for example, electrical shock, high-temperature or high-pressure fluid used in system) associated with maintenance activities on specific systems
- Describes the proper disassembly and assembly methods, including removal, replacement, repair and torquing techniques
- Describes the proper methods for adjustments and calibrations on components or systems
- Describes the methods to test a component when maintenance work is completed
  - leakage test
  - component operation
  - loop functional test
  - valve operation
- Explains the limitations of and requirements for maintenance activities associated with environmentally qualified and safety-related components and equipment
- Explains acceptable cleaning and inspection techniques for system components



- Explains the lubrication principles associated with components, including the problems associated with improper lubrication such as:
  - valves
  - pumps
  - motors
  - valve actuators
- Explains post-maintenance testing requirements and responsibilities including:
  - interdepartmental notifications (for example, Operations, Quality Control, Engineering)
  - importance of documenting maintenance actions and component parameters
  - acceptance criteria determination
  - program commitments (for example, technical specifications, industry standards, regulatory documents)
  - component testing requirements (for example, inspection, leak test, functional test, calibration) associated with a work activity
  - visual inspection characteristics (for example, component free of corrosion, fasteners/ terminations tight)
  - installation activities (for example, wiring checks, pressure tests, torque verifications)
  - operational test characteristics (for example, proper rotation, temperature, voltage, pressure)
  - Identifies alarms, indications, interlocks and automatic features affected by important maintenance activities
  - Identifies abnormal system and component

- indications and diagnoses the probable causes
- Identifies when components have been removed properly from service before maintenance activities are performed
- Identifies system cleanliness requirements and describe the methods used to prevent foreign material from entering systems and components
- Identifies industrial safety measures necessary for work in the vicinity of specific operating equipment including job aspects related to identifying, diagnosing and repairing system and component problems and using plant procedures and drawings
- Identifies proper rigging and lifting techniques for major components such as pumps and motors
- Identifies where the use of special tools or equipment (for example, cranes, scaffolding, breaker grounding devices) will be required and describes how they will be used during work on various components
- Identifies repair and surveillance procedures that will be used on the job

## **ELECTRICAL TECHNICIANS**

### **1. Maintain and Repair Equipment**

- Is able to explain the following topics:
  - basic electronics components (such as transistors BJT, FET, IGFET, MOSFET, SCR and diodes)
  - circuit functions (such as switching amplifiers, voltage regulation, limiters and rectification)
  - circuit breakers and fuses
  - construction of conductors and insulators (such as examples of various cables, shielding and failure mechanisms)
  - electron theory
  - inductance, capacitance, impedance, resonance and reactance
  - instrumentation schematics, control circuitry, ground detection and protective relaying (including the use of associated drawings for diagnosing circuit trouble)

- magnetism (such as Faraday's Law of Induction, Lenz's Law, amp-turns, volt-turns, B&H fields)
- relays
- series, parallel and combination circuits applied to AC and DC circuits
- Thevenin's and Norton's theorems
  - theory of operation of plant electrical components
  - motors (such as types and classifications)
  - generators (such as types and classifications)
  - transformers
- types, functions and operation
- fault symptoms and hazards
- safety and environmental precautions associated with cooling mediums (such as oil, air, hydrogen)
- fire protection systems
- voltage regulators
- linear and switching power supplies
- inverters (such as battery backup systems)
- Diagnoses problems and performs maintenance on the following equipment
  - electrical supply components
    - switchgear, load centers and motor control centers
    - transformers
    - inverters and uninterruptible power supplies
    - circuit breakers
    - batteries and chargers
  - electrical control components
    - relays
    - meters
    - control circuits
    - cables
  - resistive electrical equipment
    - heaters
    - heat tracing
  - rotating equipment
    - motors
    - generators
    - motor-generators
  - structural and auxiliary equipment
    - hoists and cranes
    - fire barriers
    - electric boilers
    - elevators
  - valve actuators
  - manual operation
  - testing
  - position indication
  - environmental impact
- Explains detailed construction and use of the following:
  - battery systems
  - cathodic protection systems
  - electrical distribution, including alternating and direct current systems
  - emergency power systems
  - generator excitation and control systems
  - protective relaying systems
  - station heat tracing systems
  - transformer systems and auxiliaries
- Is able to perform the following specialized tasks
  - breaker operation, setting, adjustment and repair
  - motor-operated valve diagnostic testing
  - motor overhauls
  - high potential ("hi-pot") tests
  - stress relief of major components
  - high voltage connection preparation
  - relay setting, adjustment, calibration and repair
  - special soldering
  - tempering and annealing
  - battery load testing
  - switchgear testing

## **INSTRUMENT & CONTROL TECHNICIANS**

### **1. Maintain and Repair Equipment**

- Is able to describe the following:
  - advanced electronics theory, including operational amplifiers, integrated circuits and solid state circuitry
  - digital electronics, including the different type of logics used and methods for programming and controlling circuit timing
  - electrical circuit and instrument loop schematics
  - pneumatic and hydraulic valve operator fundamentals
  - principles of operation of on-line chemistry instrumentation such as conductivity analyzers, turbidity detectors and dissolved oxygen instruments
  - process measurement systems for pressure, temperature, flow, level and vibration
  - process control, loop tuning and control fundamentals
- Diagnoses problems and performs maintenance on the following components
  - electronic equipment
  - computers/microprocessors
  - analyzers
  - signal converters
  - electrical components
    - power supplies
    - transformers
    - breakers
    - relays
  - fire barriers
  - hoists and cranes
  - instrumentation components, including problems associated with placing components into or out of service (such as valving transmitters being placed into service)
  - sensors and detectors
    - transmitters and indicators
    - recorders and annunciators
    - controllers and positioners

- structural and auxiliary equipment
- valve actuators
  - manual operations
  - alignment for remote control and/or automatic operation
  - testing
  - position indication
  - impact of environmental conditions
- Troubleshoots and repairs the following systems and equipment
  - analytical equipment
  - circuit boards
  - computers
  - turbine control system
  - variable-speed pump controls

## **WIND TECHNICIANS**

### **1. Foundational Science and Engineering Concepts**

- Is able to describe the power generation delivery grid system from generation to end user including VARS (Vertical and Azimuth Reference System)
- Describes wind energy and the way it is harnessed
- Defines kinetic energy
- Lists and describes the topography and weather patterns of states that effectively harness wind
- Explains hydraulics (brakes and/or blade/tip pitching)



- Comprehends gearing, fasteners, torquing, and lubrication (oils and greases)
- Comprehends how Material Safety Data Sheets (MSDS) are utilized
- Has a basic understanding of aviation terminology and basic aerodynamics (physics)
- Is knowledgeable in instrumentation and controls logic theory
- Has a basic understanding of fiber optics
- Has an understanding of basic rigging
- Is knowledgeable in wind turbine concepts such as:
  - Statics dynamics
  - Thermodynamics
  - Basic meteorology

## 2. System Design

- Quantifies customers' energy needs including peak-load demand
- Identifies suitable site based on soil types and obstructions
- Determine minimum tower height
- Estimates wind shear, average annual wind speed and turbulence
- Establishes system performance expectations
- Selects major components and determines general configuration
- Identifies zoning, building permit, setback, right-of-way and FAA requirements
- Determines appropriate footer, tower configuration/design, earth anchors and guy lengths based on site, soil, structural code requirements and equipment manufacturer specifications
- Determines wire sizing, de-rated ampacity, voltage drops, over-current and disconnect devices and appropriate grounding based on equipment manufacturer specifications

## 3. Install, Maintain and Repair Equipment

- Reads and follows plans, drawings, schematics and installation manuals
- Ensures proper assembly and safe installation of tilt-up towers and turbine including fasteners and guy cables and appropriate tensioning of cables
- Utilizes crane operator signals and protocols when working with a crane operator
- Installs all electrical components including inverters, controllers, grounding, lightning, surge and over-current protection devices, junction boxes, batteries, disconnects and monitoring equipment according to NEC and equipment specifications
- Programs, adjusts and configures inverters and controllers for desired set-points and operating modes
- Has knowledge of location of material and parts storage
- Has knowledge of lifting equipment and ability to access manufacturer's specifications
- Has knowledge of wind turbine components and how they interact
- Has knowledge of how the site collection system operates and interacts with the substation
- Is able to test for and determine status of wind turbines
- Is knowledgeable of normal operations of wind turbines and the ability to acquire and verify base line readings
- Visually inspects mechanical installation for structural integrity
- Verifies proper wiring practice, polarity or phase, grounding and integrity of terminations
- Observes and listens to turbine and equipment to determine if system is operating correctly
- Checks fasteners and guy cables for proper tension
- Verifies and demonstrates complete functionality and performance of the system including start-up, shut-down, normal operation and emergency or bypass operation
- Performs mechanical and electrical diagnostic procedures, implementing service procedures for the tower, fasteners, guy wires, turbine, wiring, grounding system, lightning protection and batteries
- Identifies and corrects performance issues and safety concerns



## SOLAR TECHNICIANS

- Describes solar energy and how it is harnessed
- Explains the differences between passive solar and active solar
- Is able to diagram PhotoVoltaic cells (e.g. array, panel, module and boron-enriched silicon)
- Describes a central receiver system
- Identifies parts of a solar plant
- Assembles solar modules, panels, or support structures, as specified
- Installs active solar systems, including solar collectors, concentrators, pumps or fans
- Installs photovoltaic (PV) systems in accordance with codes and standards using drawings, schematics and instructions
- Performs routine photovoltaic (PV) system maintenance on modules, arrays, batteries, power conditioning equipment, safety systems, structural systems, weather sealing or balance of systems equipment
- Activates photovoltaic (PV) systems to verify system functionality and conformity to performance expectations
- Applies weather sealing to array, building or support mechanisms
- Checks electrical installation for proper wiring, polarity, grounding or integrity of terminations
- Determines appropriate sizes, ratings and locations for all system overcurrent devices, disconnect devices, grounding equipment and surge suppression equipment
- Determines connection interfaces for additional subpanels or for connecting photovoltaic (PV) systems with utility services or other power generation sources
- Determines photovoltaic (PV) system designs or configurations based on factors such as customer needs, expectations and site conditions

## BIOMASS AND BIOFUELS TECHNICIANS

- Discusses the major sources of biomass
- Defines biofuels (e.g. ethanol, biodiesel and methanol)
- Outlines the pyramid of energy flow, including the different trophic levels
- Describes the major sources, scale and impacts of biomass energy
- Measures and monitors raw biomass feedstock, including wood, waste or refuse materials
- Operates valves, pumps, engines or generators to control and adjust production of biofuels or biomass-fueled power
- Performs routine maintenance or make minor repairs to mechanical, electrical or electronic equipment in biomass plants
- Assesses quality of biomass feedstock
- Calculates, measures, loads or mixes biomass feedstock for power generation
- Calibrates liquid flow devices or meters, including fuel, chemical and water meters
- Inspects biomass power plant or processing equipment, recording or reporting damage and mechanical problems
- Operates biomass fuel-burning boiler or biomass fuel gasification system equipment in accordance with specifications or instructions.
- Operates equipment to heat biomass, using knowledge of controls, combustion and firing mechanisms
- Operates equipment to start, stop or regulate biomass-fueled generators, generator units, boilers, engines or auxiliary systems

- Calculates, measures, loads or mixes refined feedstock used in biofuels production
- Operates chemical processing equipment for the production of biofuels
- Operates equipment, such as a centrifuge, to extract biofuels products and secondary by-products or reusable fractions
- Operates valves, pumps, engines or generators to control and adjust biofuels production
- Processes refined feedstock with additives in fermentation or reaction process vessels
- Assesses the quality of biofuels additives for reprocessing
- Calibrates liquid flow devices and meters including fuel, chemical and water meters
- Collects biofuels samples and performs routine laboratory tests or analyses to assess biofuels quality
- Inspects biofuels plant or processing equipment regularly, recording or reporting damage and mechanical problems
- Measures and monitors raw biofuels feedstock

## **GEOTHERMAL TECHNICIANS**

- Defines geothermal
- Identifies how geothermal energy can be used for generation
- Explains the process used for Geothermal Heat Pumps (GHP) and geoexchange
- Identifies and corrects malfunctions of geothermal plant equipment, electrical systems, instrumentation or controls
- Installs, maintains or repairs ground or water source-coupled heat pumps to heat and cool residential or commercial building air or water
- Monitors and adjusts operations of geothermal power plant equipment or systems
- Adjusts power production systems to meet load and distribution demands
- Backfills piping trenches to protect pipes from damage
- Calculates heat loss and heat gain factors for residential properties to determine heating and cooling required by installed geothermal systems

- Designs and lays out geothermal heat systems according to property characteristics, heating and cooling requirements, piping and equipment requirements, applicable regulations or other factors
- Determines the type of geothermal loop system most suitable to a specific property and its heating and cooling needs
- Digs trenches for system piping to appropriate depths and lay piping in trenches
- Prepares newly installed geothermal heat systems for operation by flushing, purging or other actions

## **HYDROPOWER AND MARINE ENERGY TECHNICIANS**

- Defines hydropower
- Explains how hydropower works
- Describes ways that hydropower can be utilized without harming fish and wildlife
- Defines marine energy
- Explains how marine energy works
- Identifies and addresses malfunctions of hydroelectric plant operational equipment, such as generators, transformers and turbines
- Monitors hydroelectric power plant equipment operation and performance, adjusting to performance specifications, as necessary
- Starts, adjusts and stops generating units, operating valves, gates or auxiliary equipment in hydroelectric power generating plants
- Communicates status of hydroelectric operating equipment to dispatchers or supervisors
- Implements load and switching orders in hydroelectric plants in accordance with specifications or instructions
- Inspects water-powered electric generators and auxiliary equipment in hydroelectric plants to verify proper operation and to determine maintenance or repair needs
- Installs and calibrates electrical and mechanical equipment, such as motors, engines, switchboards, relays, switch gears, meters, pumps, hydraulics and flood channels
- Maintains logs, reports, work requests and other records of work performed in hydroelectric plants

- Maintains or repairs hydroelectric plant electrical, mechanical and electronic equipment, such as motors, transformers, voltage regulators, generators, relays, battery systems, air compressors, sump pumps, gates and valves
- Operates high voltage switches and related devices in hydropower stations

**NUCLEAR GENERATION:** For information on the required competencies for nuclear generation positions, please refer to INPO's ACAD 08-006 document

## **ELECTRIC TRANSMISSION AND DISTRIBUTION:**

### **LINEWORKER**

- Installs, changes, transfers, moves and removes poles, pole line hardware, guys, transformers, lightning arresters, streetlight equipment, electrical cable, cross-arms, energized conductors, insulators, conduit, capacitor bank controls and any and all forms of electrical material and accessories utilized in the construction, maintenance and operation of electric circuits
- Installs, uses and removes protective equipment and devices on energized electric circuits of all voltages
- Works with hot line tools on circuits
- Performs steel tower structural work including the erection and removal and repair of steel towers and electrical equipment
- Installs and removes single-phase socket type meters through Class 200/240V on single family and duplex dwellings in conjunction with the installation and removal of services
- Operates switches and cutouts in transmission and distribution circuits
- Inspects poles and towers, making climbing inspections of conductors and equipment
- Drives trucks and is responsible for truck, tools and equipment
- Locates underground gas and electric facilities in conjunction with work assignment
- Cleans, tins and splices corresponding conductors by twisting ends together or by joining ends with metal clamps and soldering connections
- Climbs poles or uses truck-mounted buckets to access equipment
- Enters manholes and other confined spaces with energized cables to access equipment
- Terminates underground cabling
- Performs energized gloved hand work
- Cuts and peels lead sheathing and insulation from defective or newly installed cables and conduits prior to splicing
- Identifies defective sectionalizing devices, circuit breakers, fuses, voltage regulators, transformers, switches, relays or wiring using wiring diagrams and electrical-testing instruments
- Lays underground cable directly in trenches or strings it through conduit through the trenches
- Opens switches or attaches grounding devices in order to remove electrical hazards from disturbed or fallen lines or to facilitate repairs
- Installs and maintains street light circuits
- Sets and removes street light poles
- Performs minor tree trimming, cutting brush and removing line detriments to the extent necessary in performance of work assignment
- Understands mechanical relationships in practical situations such as understanding leverage, how pulleys work, the directions of force arrangements, turn, heat flow, centrifugal force, etc.
- Is able to visualize length, width, thickness, height or depth and the differences among shapes, widths or lengths



## SUBSTATION TECHNICIAN

- Analyzes test data in order to diagnose malfunctions, to determine performance characteristics of systems and to evaluate effects of system modifications
- Constructs new substations and installs grounding grid, equipment and connections
- Constructs, tests, maintains and repairs substation relay and control systems
- Consults manuals, schematics, wiring diagrams and engineering personnel in order to troubleshoot and solve equipment problems and to determine optimum equipment functioning
- Inspects and tests equipment and circuits to identify malfunctions or defects, using wiring diagrams and testing devices such as ohmmeters, voltmeters or ammeters
- Opens and closes switches to isolate defective relays, then performs adjustments or repairs
- Repairs, replaces and cleans equipment and components such as circuit breakers, brushes and commutators
- Runs signal quality and connectivity tests for individual cables and records results
- Disconnects voltage regulators, bolts and crews and connects replacement regulators to high-voltage lines
- Maintains inventories of spare parts for all equipment, requisitioning parts as necessary
- Is knowledgeable of circuit boards, processors, chips, electronic equipment and computer hardware and software, including applications and programming
- Installs, tests and maintains transmission and distribution metering, control and relaying systems
- Installs, tests and maintains transmission and distribution supervisory control equipment (SCADA) telemetering systems, load control equipment, line carrier, tone equipment and microwave equipment
- Performs switching of electrical substation and switch gear equipment
- Is able to use inspection sheets and forms
- Understands the tools used in substation and equipment inspection
- Is able to accurately measure quantities and obtains accurate readings
- Is knowledgeable of equipment loading and temperature limits
- Complies with safety procedures with respect to substation and field equipment inspection and knowledge of APM (Accident Prevention Manual)
- Understands and uses the documentation and reporting procedures for abnormal conditions
- Is knowledgeable of the requirements for alerting environmental authorities
- Understands blueprint symbols
- Is knowledgeable of blueprint index and updating procedures
- Stays current with inspection procedures and operating bulletins
- Demonstrates a functional knowledge of a substation one line diagram
- Demonstrates how to properly complete a substation switching order
- Identifies all equipment in a typical substation
- Reads and identifies the name plate data on substation equipment
- Describes the function of and components of a recloser relay unit
- Reads and diagnoses targets and lockout mode of a substation recloser
- Changes out a recloser relay unit
- Places a substation recloser in non-automatic operation
- Safely operates a gang operated air break transmission class switch
- Describes the component parts of a oil/vacuum break recloser
- Safely executes a buss tie and transfer breaker loads
- Checks and services a substation battery bank
- Demonstrates testing and replacing a distribution class sand fuse
- Racks out a substation recloser
- Racks out a substation regulator
- Executes the procedure to reset a tripped off recloser
- Restores power to an off-line substation
- Reads and evaluates a remote status recloser controller and switchboard operator
- Monitors and checks station conditions, recognize and investigate abnormal conditions and reports them



### SUBSTATION CONSTRUCTION

- Applies knowledge of materials, methods, and techniques to construct major utility systems such as power plants, water, sewer, communication, electrical, nuclear power, refineries and natural gas facilities
- Interprets documentation, detailed instructions, drawings or specifications about how devices, parts, equipment or structures are to be fabricated, constructed, assembled, modified, maintained or used
- Converts scaled blueprint drawing measurements to full dimensions for a given project
- Demolishes and/or disassemble and remove structures and buildings prior to repair or new construction
- Understands the uses of different types of construction cranes
- Performs crane inspections
- Safely performs crane operations
- Safely operates forklifts
- Demonstrates good lifting practices and proper rigging
- Identifies and uses proper hand signals, slings, rigging hardware and hitch configurations
- Understands basic load-handling safety practices
- Demonstrates how to work out signal use with spotters
- Installs structural steel in the construction of bridges, roads and utilities
- Erects, bolts, rivets, and/or welds fabricated structural metal members that support the structure during and after construction
- Sets steel bars (rebar) or steel mesh in forms to strengthen concrete structures
- Is knowledgeable of reinforced concrete and structural steel systems (e.g. vertical and horizontal loads on beams and columns, bending, shear, compressive and tensile stresses and deflection analysis)
- Connects wires to circuit breakers, transformers or other components
- Repairs or replaces wiring, equipment and fixtures, using hand tools and power tools
- Assembles, installs, tests and maintains electrical or electronic wiring, equipment, appliances, apparatus and fixtures, using hand tools and power tools
- Tests electrical systems and continuity of circuits in electrical wiring, equipment and fixtures, using testing devices such as ohmmeters, voltmeters and oscilloscopes, to ensure compatibility and safety of system
- Uses a variety of tools and equipment such as power construction equipment, measuring devices, power tools and testing equipment including oscilloscopes, ammeters and test lamps
- Plans layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes

### RELAY TECHNICIAN

- Conducts system troubleshooting
- Assesses parts/supplies for repair(s)
- Gathers problem-specific data and clearances (take out of service)
- Performs problem-specific troubleshooting technique repair(s) and system/equipment test
- Performs repairs on:
  - Power circuit breaker controls
  - Power transformer controls
  - Valve positioners
  - Pressure/level & temperature controllers
  - Programmable logic control
  - Regulator controls
  - Capacitor controls
  - Transmitters
  - Receivers
- Performs system functional tests, including control/instrument tests, protective relay system tests and control systems functional tests

- Performs protective relay calibration tests, including:
  - Current relaying
  - Differential relaying
  - Distance relaying
  - Breaker failure relaying
  - Communication-aided tripping
  - Voltage relaying
  - Frequency relaying
  - Pilot relaying
- Performs instrumentation calibration tests on temperature, voltage and current
- Performs metering system calibration tests, including full load, lead/lag, element balance and light load
- Obtains system-specific clearances (take out of service)
- Releases system-specific clearances (return to service)
- Maintains equipment records
- Maintains process system drawings
- Participates in tailboard safety process
- Procures job-specific inventory
- Maintains inventory control

## ENGINEERING TECHNICIAN

- Develops specifications and instructions for installation of voltage transformers, overhead or underground cables and related electrical equipment used to conduct electrical energy from transmission lines or high-voltage distribution lines to consumers
- Assembles documentation packages and produces drawing sets
- Drafts working drawings, wiring diagrams, wiring connection specifications or cross-sections of underground cables as required for instructions to installation crew
- Draws master sketches to scale showing relation of proposed installation to existing facilities and exact specifications and dimensions
- Measures factors that affect installation and arrangement of equipment such as distances to be spanned by wire and cable
- Studies work order requests to determine type of service such as lighting or power demanded by installation
- Visits proposed installation sites and draws rough sketches of location
- Determines the order of work and the method or presentation
- Explains drawings to construction crew
- Prepares and interprets specification, calculating weights, volumes and stress factors
- Uses CADD software for generating 2-D and 3-D working drawings and solid model drawings for use in other programs and to update company records with new and replacement equipment
- Inspects poles and towers, making reports to supervisor on conditions
- Locates underground gas and electric facilities in conjunction with work assignment
- Performs location look-ups and prepares work orders for storm restoration
- Performs standardized current load readings, calculates maximum generator load and recommends upgrades if the system is near full capacity
- Works closely with circuit design engineers to test and repair circuits designed by the electrical engineering design team down to the component level
- Is familiar with mechanical engineering and architectural design and construction principles
- Interprets and creates engineering drawings following the standard conventions of engineering graphical communication
- Uses sketches and CADD software as an integral tool in the design process and is able to persuasively present a design using generated drawings and computer models in a comprehensive design presentation
- Assembles, reviews, distributes and files documentation for engineering projects
- Prepares period reports and special analytical reports as requested
- Prepares charts and graphs
- Works with mainframe and PC computer systems to manage, generate and report on information as requested
- Prepares project authorizations, work orders, requisitions, retirement forms, letters and memos

## **METER TECHNICIAN**

- Installs, adjusts, calibrates, maintains and repairs various types of single phase electric meter equipment
- Discusses the technology behind three phase distribution class metering
- Assists in the installation of three-phase meters used with instrument transformers; tests all single-phase meters in service
- Ensures that metering is accurate and reliable throughout the system
- Field tests for complaint orders and consults with customers
- Participates in the investigation of energy diversion
- Identifies various types of service and meter loops

## **GAS TRANSMISSION AND DISTRIBUTION**

### **PIPEFITTERS/PIPELAYERS (Installs and maintains gas main and service piping)**

- Complies with the procedures necessary to ensure a safe and healthy work environment
- Lays out, assembles, installs and maintains pipe systems and pipe supports for use in the transmission and distribution of natural gas
- Reads, understands and creates basic prints used in the design, operation and maintenance of gas networks including engineering drawings, diagrams and schematics
- Selects pipe sizes and types and related materials, such as supports, hangers and hydraulic cylinders according to specification
- Assembles and secures pipes, tubes, fittings and related equipment according to specification by welding, brazing, cementing, soldering or threading joints
- Cuts, threads and hammers pipe to specifications using tools such as saws, cutting torches and pipe threaders and benders
- Inspects, examines and tests installed systems and pipe lines using pressure gauges, hydrostatic testing, observation and other methods
- Locates and makes the position of pipe installations, connections, passage holes and fixtures in structures, using measuring instruments such as rulers and levels
- Measures, cuts, threads and bends pipe to required angle, using hand and power tools or machines such as pipe cutters, pipe-threading machines and pipe bending machines
- Aligns and positions pipes to prepare them for welding or sealing
- Is knowledgeable of the nature of inaccuracy, misalignment and pipe strain and addresses the methods of correcting them
- Is able to describe the various devices that appear in pipelines, including bleed rings, ball and expansion joints, steam traps, drip legs, desuperheaters and measuring devices for temperature, level, flow rate and pressure
- Is knowledgeable of the differences in application of copper and plastic pipe and tubing and is able to describe the methods of assembling plastic pipe and tubing, compression and flared fittings and joining methods for grooved and compression formed fittings
- Understands brazing, soldering and the differences between the two methods
- Is knowledgeable of chemical, compressed air, fuel oil, steam and water systems
- Is able to identify piping systems according to color codes
- Digs trenches to desired or required depths by hand or using trenching tools
- Grades and levels trench bases using tamping machines or hand tools
- Locates existing pipes needing repair or replacement using magnetic or radio indicators
- Is able to identify and provide installation methods for different types of valves
- Is knowledgeable in the procedures for valve storage and handling
- Replaces, repairs or adjusts defective valve or regulator parts and tightens attachments, using hand tools, power tools and welder
- Understands the safest ways to maintain valves
- Is able to replace packing and o-rings, as well as how to open and close a valve's bonnet
- Demonstrates general trouble shooting and maintenance of several types of valves

- Is able to identify the types of valves that:
  - Start and stop flow
  - Regulate flow
  - Relieve pressure
  - Regulate the direction of flow
- Tests valves and regulators for leaks, temperature and pressure settings using precision testing equipment
- Examines valves or mechanical control device parts for defects, dents or loose attachments
- Cleans corrosives and other deposits from serviceable parts, using solvents, wire brushes or sandblaster
- Lubricates wearing surfaces of mechanical parts using oils or other lubricants
- Operates digging equipment such as back hoes and Kubota's
- Is able to use pavement breaking equipment, digging bars and hand shovels in regard to gas maintenance and emergency response activities
- Understands soil behavior as it relates to trench failures, including common indications of an unstable trench
- Is knowledgeable of typical shoring, shielding and sloping methods
- Is able to identify characteristics that may make a trench a confined space and describe the safety measures needed to work in the trench
- Understands common methods for preparing the trench for pipe installation, including stabilization, bedding and initial backfill. Describes effective methods for dewatering a trench and is able to troubleshoot dewatering equipment
- Is knowledgeable of trench and excavation practices such as:
  - the use of shoring materials per OSHA standards and covers shoring systems
  - installing a hydraulic vertical shore
  - determining the overall fall of a gas main or service
  - setting the grade and elevation of a trench
  - backfilling
- Understands and applies the principles of pipe fitting
  - Tightening collars
  - Unions
    - Right side up vs upside down
    - Make up measurement
    - Insulated
  - Ells
    - Make up measurement
    - Couplings
    - Street ells
  - Meters, spuds and nuts
  - Nipples
    - Diameter and length
  - Male and female threads
    - Pipe threader
    - Maintenance and cutting oil
  - Bushings
    - Reducers
    - End to center measurement
    - End to end measurement
  - Pipe dope
    - Use and purpose
- Explains pneumatic safety
- Explains the physical characteristics of gas



- Explains compressing gases
- Explains the pneumatic transmission of energy
- Explains the principles of compressor operation
- Identifies and explains types of gas pipeline equipment
- Identifies and explains pneumatic system components and symbols
- Demonstrates an understanding of the design limits of pipelines
- Locates underground structures
- Maintains the pipeline route
- Excavates utilities and pipeline components
- Applies coatings
- Performs flange tightening
- Runs pigs and performs maintenance pigging
- Inspects the pipeline following excavation activities and performs a leakage survey after blasting
- Conducts a leakage survey of natural gas pipelines

## **GAS SERVICE TECHNICIAN**

### **1. Emergency Response**

- Inspects service lines and house lines, investigates leak fume complaints, restores and terminates gas service and performs pressure checks at customer's premises
- Is able to use equipment to detect leaks both in a customer's premises or outdoors such as CGI gas scope leak machine and Gas Ranger
- Locates and marks out underground gas and electric facilities in conjunction with work assignment
- Troubleshoots situation to determine corrective action required to make location safe
- Repairs gas leaks as necessary or makes location safe for future repair
- Cooperates with local, state and federal agencies to ensure appropriate procedures are followed
- Shuts off gas service as necessary
- Re-lights gas equipment

### **2. Operations and Maintenance**

- Repairs and installs gas appliances and equipment such as ovens, dryers and hot water heaters
- Measures, cut and threads pipe and connects it to feeder lines and equipment or appliance using ruler and hand tools
- Tests and examines pipelines and equipment to locate leaks and faulty connections and to determine pressure and flow of gas

- Assembles new or reconditioned appliances
- Dismantles meters and regulators and replaces defective pipes, thermocouples, thermostats, valves and indicator spindles using hand tools
- Maintains stock of parts used in on-site installation, maintenance and repair of appliances
- Observes and examines appliance during operation to detect specific malfunction, such as loose parts or leaking fluid
- Replaces worn and defective parts
- Installs meters, service regulators and associated piping

## **METER AND CONTROL TECHNICIAN**

- Installs, operates and maintains odorizers, regulators and metering equipment in town border stations (TBS), district regulator stations (DRS) and industrial regulator and meter stations
- Repairs and calibrates and replaces corrected reading instruments such as emcorrectors and base pressure indexes
- Repairs, tests, calibrates and replaces all types of positive meters including rotary displacement meters
- Replaces parts and equipment such as valves and diaphragms
- Disassembles, repairs and reassembles all types of control regulators and relief regulators including self operating, pilot operating and control valves
- Repairs and replaces parts and equipment such as seats, springs and diaphragms
- Makes required tests, inspections and surveys including leak tests, pressure tests, insulation tests, field tests and repair of large capacity meters
- Makes pressure surveys using prescribed methods
- Makes periodic checks on delivery pressure and operation of all regulators, control valves and odorizing equipment
- Regularly inspects, greases and checks for proper operation of transmission and distribution system and large consumer gas valves
- Sets, tests, repairs and calibrates orifice gauges, telemetering and Remote Operating Controllers (ROC)
- Checks, repairs and calibrates recording thermometers

- Estimates, calculates and applies volume of gas to line used by customers while operating bypass and is responsible for maintaining service to customer during such bypass
- Makes calculations to obtain various factors that are used in testing meters with critical flow prover, low pressure flow prover and computer operated transfer flow prover
- Installs, maintains and repairs regulators, regulator pits, structures and piping, large commercial and industrial meters, city gate stations, pressure relief devices, recording devices and other related equipment
- Maintains charts at commercial and industrial meters and regulator locations

## WELDER

- Understands and applies the principles of pipe fitting
    - Tightening collars
    - Unions
      - Right side up vs upside down
      - Make up measurement
      - Insulated
    - Ells
      - Make up measurement
      - Couplings
      - Street ells
    - Meters spuds and nuts
    - Nipples
      - Diameter and length
    - Male and female threads
      - Pipe threader
      - Maintenance and cutting oil
    - Bushings
      - Reducers
      - End to center measurement
      - End to end measurement
    - Pipe dope
      - Use and purpose
  - Is able to explain and identify proper personal protection used in welding
  - Demonstrates safety techniques for storing and handling cylinders.
- Explains how to avoid electric shock when welding
  - Identifies and explains the use of oxyfuel cutting equipment
  - Is able to perform oxyfuel cutting
    - Straight line and square shapes
    - Piercing and slot cutting
    - Bevels
    - Washing
    - Gouging
  - Is responsible for the care, maintenance and correct use of the following types of general hand tools:
    - Pipe vise
    - Pipe wrenches (leverage/backwards)
    - Channel locks (leverage/backwards)
    - Hook knives
    - Pressure gauges/air gauges
  - Is responsible for the care, maintenance and correct use of the following special welding tools:
    - Rubber service stoppers
    - Expander plug stopper
    - Cutters
    - Squares
    - Center finders
    - Flange levels
    - Wrap arounds



## **Tier 7 Industry-Specific Job Specific Education and Certification | Energy Generation, Transmission and Distribution**

### **NON-NUCLEAR GENERATION**

- High school diploma or GED
- Basic knowledge of first aid and CPR
- Possession of a valid driver's license
- SEAL license (state requirement)
- Physical Requirements
  - Is able to perform manual work, i.e., standing, stooping and walking
  - Is able to lift up to 45 lbs
  - Is able to climb ladders 200+ feet above the ground without assistance on a frequent basis
  - Is able to work outdoors in extreme cold and heat for extended periods of time
  - Is able to work in noisy conditions
  - Is able to work in enclosed spaces
  - Is able to discriminate between fine visual details at eighteen inches or less (inspecting a part, machining a piece, reading a print, etc.)
  - Is able to recognize colors, for example in distinguishing wires, resistors, containers or light signals
  - Is able to detect heat or vibration in equipment or machinery parts by feeling
  - Is able to use one's hands and fingers to adjust or manipulate hand controls, tools or objects based on what is seen or to coordinate actions
  - Is able to climb stairs and ladders, operate stiff valves manually, lift weights, control pneumatic or hydraulic wrenches

### **ELECTRIC TRANSMISSION AND DISTRIBUTION**

- Must possess a high school diploma or equivalent
- Must possess a valid driver's license
- Must possess or be able to obtain a Commercial Driver's License
- Must be able to ascend and descend poles, structures, manholes, etc.

- Is able to discriminate between visual details at distances beyond arm's length (e.g., scanning a control panel, looking for surface flaws, spotting circuit breakers, etc.)
- Is able to see details at close range
- Is able to keep hand and arm steady while moving arm or holding arm and hand in one position
- Is able to quickly move hand, hand together with arm or two hands to grasp, manipulate or assemble objects
- Is able to identify attributes of objects such as size, shape, temperature or texture, principally by means of the fingertips
- Is able to recognize colors, for instance in distinguishing wires, resistors, containers or light signals
- Is able to lift, push, pull or carry objects greater than 50 lbs
- Is able to work in confined spaces
- Is able to climb poles 35+ tall or work in a truck-mounted bucket
- Is able to work in situations involving physical danger or discomfort
- Is willing to work in all types of weather conditions

### **GAS TRANSMISSION AND DISTRIBUTION**

- Must possess a high school diploma or equivalent
- Must possess a valid driver's license
- Refrigeration license desirable
- Is able to see details at close range
- Is able to keep hand and arm steady while moving arm or holding arm and hand in one position
- Is able to quickly move hand, hand together with arm or two hands to grasp, manipulate or assemble objects
- Is able to lift, push, pull or carry objects greater than 50 lbs
- Is able to use a jack hammer or other similar equipment
- Is able to drive construction equipment such as a back hoe or Kubota
- Is able to work in confined spaces

Formed in March 2006, the Center for Energy Workforce Development (CEWD) is a non-profit consortium of electric, natural gas, and nuclear utilities, contractors and their associations—Edison Electric Institute, American Gas Association, American Public Power Association, Nuclear Energy Institute, National Rural Electric Cooperative Association, and Distribution Contractors Association.



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Center for Energy Workforce Development (CEWD)



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