TIERS 5-8: NON-NUCLEAR GENERATION

***DRAFT:* NOT INTENDED FOR USE IN CURRICULUM DEVELOPMENT UNTIL VALIDATED BY INDUSTRY REPRESENTATIVES. CHECK THE CEWD WEBSITE FOR THE LATEST PROGRESS ON THE PROJECT.**

TIER 5: INDUSTRY-SPECIFIC TECHNICAL COMPETENCIES

Non-nuclear Generation: Technical skills and knowledge necessary for gas, oil, coal, hydro, wind, solar and other alternative energy fuels power plant personnel.

1. Science and Engineering Theory and Concepts

- Explains the differences and similarities of power generation, including use of different fuel types, different plant uses (i.e., peaking, load following, base load)
- 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 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
- Has a basic knowledge of water and general chemistry

2. 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 hosts 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_2, O_2 and chemical)
  - signal converters
- Explains the principles associated with instrumentation and control and describe 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

3. Computer Skills

- Is knowledgeable 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

TIERS 6 –7: OCCUPATION-SPECIFIC TECHNICAL KNOWLEDGE

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 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 knowledgeable 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

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

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 discuss the possible diagnostic and repair actions that may be necessary
- Describe the proper methods and practices for safe troubleshooting of defective components
- Describe the proper methods for breaching systems, including applicable radiological exposure and contamination controls
- Describe the application and operation of various devices (for example, video cameras, filter removal tools and remotely operated machines) used for radiological exposure reduction

- Describe potential hazards (for example, electrical shock, high-temperature or high-pressure fluid used in system) associated with maintenance activities on specific systems
- Describe the proper disassembly and assembly methods, including removal, replacement, repair and torquing techniques
- Describe the proper methods for adjustments and calibrations on components or systems
- Describe the methods to test a component when maintenance work is completed
  - leakage test
  - component operation
  - loop functional test
  - valve operation
- Explain the limitations of and requirements for maintenance activities associated with environmentally qualified and safety-related components and equipment
- Explain acceptable cleaning and inspection techniques for system components
- Explain the lubrication principles associated with components, including the problems associated with improper lubrication such as:
  - valves
  - pumps
  - motors
  - valve actuators
- Explain post-maintenance testing requirements and responsibilities including:
  - interdepartmental notifications (for example, operations, quality control and engineering)
  - importance of documenting maintenance actions and component parameters
  - acceptance criteria determination
  - program commitments (for example, technical specifications, industry standards and regulatory documents)
  - component testing requirements (for example, inspection, leak test, functional test and calibration) associated with a work activity
  - visual inspection characteristics (for example, component free of corrosion and fasteners/terminations tight)
  - installation activities (for example, wiring checks, pressure tests and torque verifications)
  - operational test characteristics (for example, proper rotation, temperature, voltage and pressure)
- Identify alarms, indications, interlocks and automatic features affected by important maintenance activities
- Identify abnormal system and component indications and diagnose the probable causes
- Identify when components have been removed improperly from service before maintenance activities are performed
- Identify system cleanliness requirements and describe the methods used to prevent foreign material from entering systems and components
- Identify 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

- Identify proper rigging and lifting techniques for major components such as pumps and motors
- Identify where the use of special tools or equipment (for example, cranes, scaffolding and breaker grounding devices) will be required and describe how they will be used during work on various components
- Identify 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 and 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 perform 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
- Diagnose problems and perform 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
- Troubleshoot and repair 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)
- 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. Maintain and Repair Equipment

- 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

TIER 8: DEGREES, LICENSES, CERTIFICATES, CREDENTIALS, EXPERIENCE, PHYSICAL CAPABILITIES

- 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 and control pneumatic or hydraulic wrenches

TIERS 5-8: ELECTRIC T & D

***DRAFT:* NOT INTENDED FOR USE IN CURRICULUM DEVELOPMENT UNTIL VALIDATED BY INDUSTRY REPRESENTATIVES. CHECK THE CEWD WEBSITE FOR THE LATEST PROGRESS ON THE PROJECT.**

TIER 5: INDUSTRY SECTOR TECHNICAL COMPETENCIESELECTRIC 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 the components and workings of the electric transmission and distribution network
- Applies direct current (DC) concepts and laws
  - 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 and 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 and 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) 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

- 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 design, uses, repair and maintenance
- Is able to work with electrical instruments such as voltmeters, ammeters, fault locators, etc.
- Understands the application of hosts, 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

TIERS 6-7: OCCUPATION-SPECIFIC TECHNICAL KNOWLEDGE

LINEWORKER

1. Operations and Maintenance

- 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

- 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 fear 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/RELAY TECHNICIAN

1. Operation and Maintenance

- Analyzes test data in order to diagnose malfunctions, to determine performance characteristics of systems and to evaluate effects of system modifications
- 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

ENGINEERING TECHNICIAN

- Develops specifications and instructions for the 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 the installation crew
- Draws master sketches to scale showing the relation of proposed installations to existing facilities and the exact specifications and dimensions
- Measures factors that affect installation and the arrangement of equipment such as distances to be spanned by wire and cable
- Studies work order requests to determine the type of service such as lighting or power demanded by the installation
- Visits proposed installation sites and draws rough sketches of the location
- Determines the order of work and the method or presentation
- Explains drawings to the construction crew
- Prepares and interprets specification, calculating weights, volumes and stress factors
- Uses CADD software to prepare drawings and to update company records with new and replacement equipment
- Inspects poles and towers, making reports to the supervisor on conditions
- Locates underground gas and electric facilities in conjunction with the work assignment
- Performs location look-ups and prepares work orders for storm restoration

TIER 8: LICENSES, EDUCATION, CERTIFICATION AND PHYSICAL REQUIREMENTS

- Must possess a high diploma or GED
- Must possess a valid driver's license
- Must possess a Commercial Driver's License

Physical Requirements

- 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+ feet 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

***DRAFT:* NOT INTENDED FOR USE IN CURRICULUM DEVELOPMENT UNTIL VALIDATED BY INDUSTRY REPRESENTATIVES. CHECK THE CEWD WEBSITE FOR THE LATEST PROGRESS ON THE PROJECT.**

TIER 5: INDUSTRY SECTOR TECHNICAL COMPETENCIES

NATURAL 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
  - 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, and 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, and impedance)
  - passive components, capacitors, and 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 the 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 6-7: OCCUPATION-SPECIFIC TECHNICAL KNOWLEDGE

PIPEFITTERS/PIPELAYERS

1. 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 of 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, superheaters 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

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 assignments
- 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, cuts and threads pipe and connects it to feeder lines and equipment or appliances 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 appliances 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

1. Operations and Maintenance

- 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, 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 repairs 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 systems 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 a 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
- Meter 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 8: LICENSES, EDUCATION, CERTIFICATION AND PHYSICAL REQUIREMENTS

- Must possess a high diploma or GED
- Must possess a valid driver's license
- Refrigeration license desirable

Physical Requirements

- 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