

Industry Identified Knowledge and Skill Requirements

Mechanical, Electrical and Instrumentation and Controls Knowledge and Skill requirements are based on information provided by ESTEC partners, utilities and energy companies, interviews with employers, and on-site plant visits.

Adopted competency requirements were those most frequently identified.

Additional competences unique to Nuclear Energy are not included in this matrix.

Instrumentation and Controls competencies have been vetted by the Center for Energy Workforce Development and have been accepted for use in the Energy Industry Competency Model: Generation, Transmission and Distribution

<http://www.cewd.org/documents/energymodel.pdf>

Mechanical Engineering Technology (MET), Electrical Engineering Technology (EET), Instrumentation and Controls Engineering Technology (ICET)	DISCIPLINE		
	MET	EET	ICET
MATHEMATICS			
Perform basic arithmetic functions	X	X	X
addition	X	X	X
- subtraction	X	X	X
- multiplication	X	X	X
- division	X	X	X
- fractions and decimals	X	X	X
- percentage	X	X	X
- square roots	X	X	X
- ratios	X	X	X
Perform basic calculations that involve significant figures including measurement	X	X	X
Perform calculations that involve logarithms/exponential functions including:	X	X	X
- graphing	X	X	X
- solving for the exponent	X	X	X
- solving for any variable	X	X	X
- base e	X	X	X
- base 10	X	X	X

Apply scientific and engineering notation in calculations including conversion of numbers	X	X	X
Demonstrate the ability to apply the concept of dimensional analysis and to perform:	X	X	X
- unit conversions	X	X	X
- unit modifiers	X	X	X
- metric measurements such as conversion between metric and the U.S. customary system	X	X	X
Perform basic algebraic operations including calculations of:	X	X	X
- area	X	X	X
- volume	X	X	X
Perform basic trigonometric operations such as simple right triangle calculations of:	X	X	X
- sine	X	X	X
- cosine	X	X	X
- tangent	X	X	X
Create and interpret graphs and control charts including	X	X	X
- graphing data	X	X	X
- obtaining information from graphs and control charts and nomograms	X	X	X
- rectangular coordinate system	X	X	X
- logarithmic coordinate system	X	X	X
Perform basic statistical analysis of a data set including	X	X	X
- Mean. Mode. Standard deviation	X	X	X
- perform a probabilistic analysis of events	X	X	X
BASIC PHYSICS			
Develop an understanding of Systems International (SI) and American Standard units including	X	X	X
- measuring pressure	X	X	X
- temperature	X	X	X
- flow	X	X	X

- volume	X	X	X
- mass	X	X	X
- weight	X	X	X
- distance	X	X	X
- time	X	X	X
Perform basic calculations and apply concepts for the following:	X	X	X
- density, height and temperature effects on process fluids, mass, fluid mechanics, weight and heat	X	X	X
- temperature system conversions such as Rankin, Fahrenheit, Kelvin, Celsius	X	X	X
- temperature measuring systems	X	X	X
Perform basic calculations and apply concepts for acceleration, distance and velocity	X	X	X
Perform basic calculations and apply concepts for the following:	X	X	X
- energy	X	X	X
- force	X	X	X
- momentum	X	X	X
- power	X	X	X
- work	X	X	X
Perform basic calculations and apply concepts for the following:			
- conditions of equilibrium	X	X	X
- conservation of energy	X	X	X
- conservation of momentum	X	X	X
- laws of motion, such as linear and rotational	X	X	X
Explain the basic principles of mechanical concepts including the following:	X	X	X
- purposes and necessity of lubrication principles (such as the coefficient of friction, viscosity, heat dissipation)	X	X	X
- mechanical principles (such as simple machines, functions of components such as levers, gears, cams and pulleys)	X	X	X
BASIC ELECTRICITY			

Apply direct current (DC) concepts and laws; perform calculations and measurements including the following	X	X	X
- basic electrical circuits such as series and parallel, series-parallel combinations	X	X	X
- conductors and insulators	X	X	X
direct current (DC) theory and DC sources (such as ideal voltage and current, non-ideal voltage and current)	X	X	X
- electrical laws (such as Ohm's law, Kirchhoff's voltage and current laws)	X	X	X
- electron theory	X	X	X
- units of electrical measurement (such as ohms, volts, amps, watts, coulombs, joules)	X	X	X
- voltage, current, resistance and power	X	X	X
Apply alternating current (AC) concepts and laws and perform calculations and measurements including the following	X	X	X
alternating current (AC) theory and AC sources	X	X	X
- basic electrical circuits such as series and parallel	X	X	X
- units of electrical measurement	X	X	X
- passive components, capacitors, inductors	X	X	X
- single-phase and poly-phase current	X	X	X
- voltage, current, impedance, real, reactive, apparent power and power factor relationships	X	X	X
Explain the basic concepts and functions s of:			
- grounding systems	X	X	X
- electrical hazards and safety	X	X	X
- electrical power sources	X	X	X
- power distribution (AC and DC)	X	X	X
Explain the following topics:			
- basic electronics components (such as transistors BJT, FET, IGFET, MOSFET, SCR and diodes)		X	X
- basic digital gates	X	X	X
-digital electronics including counters, times clocks		X	X
- circuit functions (such as switching amplifiers, voltage regulation, limiters and rectification)		X	X

- circuit breakers and fuses	X	X	X
- electron theory	X	X	X
- inductance, capacitance, impedance, resonance and reactance	X	X	X
- magnetism (such as Faraday's Law of Induction, Lenz's Law, amp-turns, volt-turns, B&H fields)	X	X	X
- relays	X	X	X
- series, parallel and combination circuits applied to AC and DC circuits	X	X	X
- Thevenin's theorems	X	X	X
- theory of operation of plant electrical components	X	X	X
-- motors (such as types and classifications)	X	X	X
-- generators (such as types and classifications)	X	X	X
-- transformers		X	X
-- voltage regulators		X	X
-- linear and switching power supplies		X	X
-- inverters (such as battery backup systems)	X	X	X
HEAT TRANSFER AND FLUID FLOW			
Explain principles and concepts related to heat including the following:	X	X	X
-heat transfer mechanisms and heat exchanger construction and types	X	X	X
- temperature including temperature scales, R,F, C and K	X	X	X
Explain the concepts and principles of steam including the following:			
- basic steam-water cycle	X	X	X
- boiling and saturation	X	X	X
- pressure-temperature relationship	X	X	X
- properties of steam and water including pressure-temperature relationship	X	X	X
- steam tables	X	X	X
Explain the principles of heat transfer including the following:			

- heat transfer mechanisms such as conduction, convection and radiation	X	X	X
- heat exchangers	X	X	X
- latent and sensible heat	X	X	X
- thermal efficiency	X	X	X
Explain principles of fluid flow including the following			
- effects of throttling on flow and pressure	X	X	X
- filling and venting - understanding the concept of high point vents relating to air binding and water hammer	X	X	X
- fluid properties and mechanics including laminar and turbulent flow	X	X	X
- flow within a closed system to include water hammer, heating, draining, filling and venting and the effects of throttling	X	X	X
- pump theory including cavitation	X	X	X
- water hammer types and mechanisms	X		
PROPERTIES OF MATERIALS			
Explain basic material properties including	X	X	X
- alloy definition and application	X	X	X
- compressive strength	X	X	X
- expansion/contraction associated with temperature changes	X	X	X
- heat treating and annealing related to the properties of metals	X	X	X
- radiation-induced embrittlement by neutron exposure	X	X	X
- material strength	X	X	X
- structure basics and changes in structure	X	X	X
- torque limits	X	X	X
- yield and tensile strength	X	X	X
Explain brittle fracture characteristics, mechanisms and temperature effects such as heat up and cool down	X	X	X
Explain plant material problems including the following			
- corrosion - types including general and specific	X	X	X

-- pit and crevice	X	X	X
-- galvanic	X	X	X
-- chloride stress	X	X	X
-- caustic stress	X	X	X
-- stress corrosion cracking, including intergranular stress corrosion cracking (IGSCC)	X	X	X
-- microbiologically-induced corrosion (open system sources such as marine growth)	X	X	X
- effects of contaminants on corrosion and material properties	X	X	X
- erosion, including flow-accelerated corrosion and cavitation	X	X	X
- fatigue failure/work hardening	X	X	X
- thermal shock/stress definition, causes and effects	X	X	X
-vibration induced cracking	X	X	X
BASIC CHEMISTRY			
Explain and apply the basic fundamentals of chemistry including the following			
- acids and bases	X	X	X
- conductivity	X	X	X
- ion exchangers	X	X	X
- mixtures, solutions, and compounds	X	X	X
- molecules	X	X	X
- Periodic Table	X	X	X
- pH	X	X	X
- properties and uses of gases	X	X	X
- states of matter	X	X	X
- units of measure	X	X	X
Explain and apply basic water chemistry control fundamentals including the following			
- effects of impurities	X	X	X

- ion exchange theory	X	X	X
- parameters monitored (such as pH, conductivity, sodium, chlorides, fluorides, sulfates, hardness, silica)	X	X	X
- principles of water treatment (such as water purification with filters/reverse osmosis)	X	X	X
- sources of impurities (such as tube leaks in heat exchangers/condensers)	X	X	X
- the corrosion process including types characteristics and prevention	X	X	X
- water chemistry control methods	X	X	X
BASIC POWER PLANT COMPONENT KNOWLEDGE			
Describe the theory, construction and application of the following mechanical components:			
- Air compressors (such as rotary, reciprocating, and centrifugal)	X	X	X
- Heat exchangers (such as cross-flow, counter-flow and parallel flow)	X	X	X
- Pumps, ejectors, and eductors such as for pumps (centrifugal, positive displacement)	X	X	X
--- centrifugal pump laws, series and parallel operation	X	X	X
-- net positive suction head	X	X	X
-- requirements of minimum flow and effects of dead-heading pump	X	X	X
-- causes and indications of cavitation and how to prevent it	X	X	X
- Strainers, filters, and traps, including demineralizers, screens, and centrifuges for process filtration systems	X	X	X
- Steam traps (such as lever-operated, piston-operated and float-operated)	X	X	X
- Steam turbines	X	X	X
- Valves and limitation of different valve types	X	X	X
Describe the theory, construction and application of diesel engines including the following			
- Accessories/support systems	X	X	X
- Failure mechanisms and systems	X	X	X
- Main structural components	X	X	X
- Main moving components	X	X	X
- Principles of operations	X	X	X

Describe the theory, construction and application HVAC and the basic refrigeration cycle	X		
Describe the theory, construction and application of structural and auxiliary equipment including the following:			
- boilers (such as PC, CFB, HRSG)	X	X	X
- hangers and snubbers for support and restraint rejoining and condensate induced)	X		
- hoists and cranes (such as manual and electric)	X	X	X
Describe the theory, construction and application of rotating equipment including the following			
- generators	X	X	X
- motors	X	X	X
- motor-generators	X	X	X
Describe the theory, construction and resistive electrical equipment including the following			
- heaters	X	X	X
- heat tracing (such as reasons for using heat tracing)	X	X	X
Describe the theory, construction and application of electrical supply components including the following			
- batteries and chargers	X	X	X
- circuit breakers (such as protection)	X	X	X
- inverters and uninterruptible power supplies		X	X
- switchgear, load centers, and motor control centers such as protective relaying		X	X
- transformers (such as step-up transformers and step-down transformers, winding configurations)		X	X
Describe the theory, construction and application of electrical control components including the following			
- cables (such as routing for train separation and methods of fire detection/protection for cables/cable trays)	X	X	X
- control circuits		X	X
- meters		X	X
- relays		X	X
- PLC. Including system interface and initial configuration\		X	X
Describe the theory, construction and application of valve actuator types			

- manual operation (such as methods used for different types of actuators)	X	X	X
- position indication	X	X	X
- impact of environmental conditions	X	X	X
Describe the theory and application of electronic equipment including the following			
- analyzers			
- computers/micro-processors			
- signal converters			
Describe the theory, construction and application of diesel engines including the following			
- Accessories/support systems		X	X
- Failure mechanisms and systems		X	X
- Main structural components	X		X
- Main moving components	X	X	X
- Principles of operations	X	X	X
Describe the theory, construction and application of structural and auxiliary equipment including the following:			
- boilers (such as electric, gas-fired, fuel-oil-fired)	X	X	X
Describe the theory and application of electronic equipment including the following			
- analyzers (such as H ₂ , O ₂ and chemical)			X
- computers/micro-processors			X
- signal converters			X
Explain the principles associated with steam turbines and describe the following			X
- main components (such as shaft, turbine nozzles, bearings, control and stop valves)	X	X	X
- classification according to steam flow (such as straight, reheat and extraction)	X	X	X
- principles of operation (such as for impulse and reaction turbines)	X	X	X
- accessories/support systems (such as electro hydraulic controls, condensers, moisture separators, preheaters)	X		X
- failure mechanisms and symptoms (such as over speed, loss of condenser vacuum, high vibration)	X		X

Explain the principles associated with heat exchangers and describe the following			X
- purpose (such as heating, cooling, condensing, steam generators)	X	X	X
- classification by flow (such as cross-flow, counter-flow and parallel flow)	X	X	X
- classification by heat transfer process	X		X
- major components (such as shell, tubes, relief valves, vacuum breakers)	X		X
- principles of operation	X		X
- failure mechanisms and symptoms (such as air binding, tube leaks, heat transfer reduction)	X		X
Explain the principles associated with air compressors and describe the following			X
- types (such as rotary, reciprocating, centrifugal)	X	X	X
- classifications	X	X	
- components (such as staging, relief valve, cooling water)	X	X	X
- principles of operation	X		X
- failure mechanisms and symptoms (such as power loss, line ruptures, air pressure reduction, air operated component repositioning)	X		X
Explain the principles associated with diesel engines and describe the following			
- principles of operation (such as internal combustion)	X	X	X
- main structural components (such as frame, block, pedestal, fuel distribution system)	X	X	X
- main moving components (such as pistons, cylinders, crankshaft, bearings, valves, control air, turbochargers)	X	X	X
- accessories/support systems (such as air start, cooling water, lube oil, electrical, fuel oil distribution)	X	X	X
- failure mechanisms and symptoms (such as failure to start, failure to reach operating speed, failure to stop, rough idling)	X		X
Explain the principles associated with electrical generation and distribution and describe the following			
- switchgear, load centers, and motor control centers (such as protective tripping)	X	X	X
- switchyard equipment (such as equipment monitoring)	X	X	X
- transformers (such as types and configuration (for example, Delta-wye) step up/step down)		X	X
- motors and control circuits (such as startup and shutdown, protection devices)		X	X
- generators (such as operation and monitoring of diesel-driven, turbine-driven, motor-generators)		X	X

- impact of environmental conditions		X	X
Explain the principles associated with instrumentation and control and describe the following			
- basic control circuits (PID; saturation cutoff, steady-state error, limiters, effects of disturbances)		X	X
- pneumatic devices (such as actuators)	X	X	X
- sensors (such as types of sensors, for example, pressure, flow, temperature)	X	X	X
- hydraulic controls (such as actuators)		X	X
BASIC TOOLS AND EQUIPMENT			
Explain procedures to check out and return radioactive contaminated tools and test equipment.	X	X	X
Identify power sources that may be connected to tools and test equipment.	X	X	X
Explain the requirements for instruments and test equipment calibration.	X	X	X
Explain how to determine tool and equipment calibration status.	X	X	X
Describe proper methods of protecting tools and test equipment for the following	X	X	X
- In a confined space	X	X	X
- When working from heights	X	X	X
- When working near open systems	X	X	X
WATER TREATMENT			
Explain ion exchange theory	X	X	X
Identify ion exchange resins (such as anion, cation, mixed bed)	X	X	X
Describe the ion exchange process	X	X	X
- bed exhaustion indications (differential pressure, silica, breakthrough)			X
- bed regeneration			X
- problems with calcium sulfate precipitation			X
- problems with organic fouling			X
Discuss resin degradation			X
PLANT SYSTEMS AND COMPONENTS KNOWLEDGE			

Explain clearance/tagging requirements	X	X	X
Describe the proper methods for handling and disposing of waste or hazardous materials that result from system maintenance	X	X	X
Describe component failure modes and discuss the possible diagnostic and repair actions that may be necessary	X	X	X
Describe the proper methods and practices for safe troubleshooting of defective components	X	X	X
Describe potential hazards associated with maintenance activities on specific systems	X	X	X
Describe the proper disassembly and assembly methods, including removal, replacement, repair and torquing techniques	X	X	X
Describe the proper methods for adjustments and calibrations on components or systems	X	X	X
Describe the methods to test a component when maintenance work is completed	X	X	X
- leakage test	X		X
- component operation	X		X
- loop functional test	X	X	X
- valve operation	X	X	X
Describe the administrative controls for performing local and manual operation of components during maintenance activities	X	X	X
Explain the limitations of and requirements for maintenance activities associated with the environment	X	X	X
Explain acceptable cleaning and inspection techniques for system components	X	X	X
Explain the lubrication principles associated with components, including the problems associated with improper lubrication:	X	X	X
- valves	X	X	X
- pumps	X	X	X
- motors	X	X	X
- valve actuators	X		X
Explain post-maintenance testing requirements and responsibilities including:			
- interdepartmental notifications (for example, Operations, Quality Control, Engineering)	X	X	X
- importance of documenting maintenance actions and component parameters	X	X	X
- acceptance criteria determination	X	X	X
- program commitments (for example, technical specifications, industry standards, regulatory documents)	X	X	X

- component testing requirements (inspection, leak test, functional test, calibration) associated with a work activity	X	X	X
- visual inspection characteristics (for example, component free of corrosion, fasteners/terminations tight)	X	X	X
- installation activities (for example, wiring checks, pressure tests, torque verifications)	X	X	X
- operational test characteristics (for example, proper rotation, temperature, voltage, pressure)	X	X	X
Identify alarms, indications, interlocks and automatic features affected by important maintenance activities	X	X	X
Identify abnormal system and component indications and diagnose the probable causes	X	X	X
Identify when components have been removed properly from service before maintenance activities are performed	X	X	X
Identify system cleanliness requirements and the methods used to prevent foreign material from entering systems	X	X	X
Identify industrial safety measures necessary for work in the vicinity of specific operating equipment	X	X	X
Identify proper rigging and lifting techniques for major components such as pumps and motors	X	X	X
Identify where the use of special tools or equipment will be required and describe how they will be used during work	X	X	X
Identify repair and surveillance procedures that will be used on the job	X	X	X
DISCIPLINE LEVEL PLANT MAINTENANCE SKILLS			
Perform the following in a controlled environment using station procedures specific to the maintenance discipline			
- apply cleanliness requirements and maintain debris control (for example, cover openings, account for tools, clean surfaces)	X	X	X
- calibrate and test instrument loops	X	X	X
- cut and replace gaskets	X	X	X
- cut fasteners to length and clean threads	X	X	X
- crimp and heat-shrink lugs and splices	X	X	X
- devise appropriate rigging and lifting strategies	X	X	X
- demonstrate assembly and disassembly methods	X	X	X
- demonstrate adjustment and calibration practices	X	X	X
- demonstrate repair (for example, adjustment, filing, cleaning) and replacement techniques	X		
- inspect and maintain environmentally qualified components and equipment	X	X	X
- install piping and conduit supports		X	

- install tubing and make up fittings, including capillary instrumentation and instrument valves			X
- lubricate components such as couplings, bearings, motors and valves	X	X	
- maintain parts accountability	X	X	X
- operate shop machinery and equipment	X	X	X
- perform or simulate post maintenance tests	X	X	X
- place compressed gas containers into and out of operations	X	X	X
- replace and torque fittings, bolts and other fasteners	X	X	X
- replace components such as switches, circuit boards and valve internals		X	X
- replace and clean filter elements	X	X	X
- remove and add refrigerant to air-conditioning systems	X	X	X
- remove corrosion from surfaces	X		
- select and use tools	X	X	X
- use appropriate measuring and test equipment properly (for example, indicator, megger, decade box)		X	X
- wrap and tape wire	X	X	X
Describe the following components, equipment and related topics			
- air handlers	X	X	
- chillers	X	X	X
- compressors	X	X	X
- control of administrative activities such as completing a work order and providing turnover status	X	X	X
- diesel generators	X	X	X
- effects of changes	X	X	X
-- processors		X	X
--sensors		X	X
-- controllers			X
-- adjustments			X

-- calibrations			X
--tests			X
- electrical equipment		X	X
-- circuit breakers		X	X
-- battery chargers		X	X
-- inverters		X	X
-- relays		X	X
-- transformers		X	X
-- conductor splicing and terminating		X	X
- filters, educators, traps and heat exchangers		X	X
-- breaching systems and exercise repair, replacement and testing techniques	X		
- human factors problems associated with plant equipment	X	X	X
- influences of harsh environmental conditions such as low lighting and tight working clearances	X	X	X
- instrumentation and processors			
-- control systems (level, pressure and temperature)			X
- medium-sized pump and motor packages similar to component cooling or charging water pump assemblies	X		X
-- seal, bearing and coupling components	X	X	X
-- bolt torquing and foreign material exclusion	X	X	X
- oral communications with station personnel involved with maintenance activities	X	X	X
- packing replacement and adjustment	X	X	X
- rotating and processing conditioning equipment	X	X	X
- signal processing equipment	X	X	X
- use of operating experience information	X		
- valves and valve actuators			
-- ball, butterfly, gate, globe, check and relief valves	X	X	X

-- disassembly and assembly	X	X	X
-- cleaning	X	X	
-- lubricating	X	X	
-- inspecting	X		
-- seat machining	X		
- valve actuators repair and testing	X		
-- motor		X	X
-- pneumatic	X		X
-- solenoid	X	X	X
- verification of important safety and status control functions such as checking the tagged boundary	X	X	X
Describe the operation and use of the following:			
- air conditioning, heating and ventilations systems (such as refrigeration machines)	X		
-- types	X		
-- structural components	X		
-- accessories/support systems	X		
- compressors including rotary, reciprocating and centrifugal	X		
- diesel engines	X	X	
- heat exchangers	X		
- pumps, ejectors and eductors	X		
-- components (such as seals, couplings and gear boxes)	X		
-- applications	X		
-- impact of environmental conditions (such as dust and moisture)	X		
-- auxiliary support equipment (such as cooling water heat exchangers, auxiliary impellers and drain systems)	X		
- strainers, filters and traps (such as demineralizers, screens and centrifuges)	X		
- steam traps	X		

- steam turbines	X		
-- construction	X		
-- main components	X		
-- accessories/support systems	X		
- structural and auxiliary equipment	X		
-- hangers and snubbers	X		
-- hoists and cranes	X		
-- boilers	X		
- valves and dampers	X		
-- applications	X		
-- functions	X		
-- components	X		
-- position indication	X		
-- actuators	X		
Perform the following specialized tasks	X		
- basic machining	X		
- basic welding	X		
- reduction gear and gear drive work	X		
- handling specialized rigging operations for jobs such as reactor vessel disassembly or main turbine maintenance	X		
- installing, inspecting and removing scaffolding	X		
- overhauling and aligning pumps	X		
Diagnose problems and perform maintenance on the following equipment		X	
- electrical supply components		X	
-- switchgear, load centers and motor control centers		X	
-- transformers		X	

-- inverters and uninterruptible power supplies		X	
-- circuit breakers		X	
- batteries and chargers		X	
- electrical control components		X	
-- relays		X	
-- meters		X	
-- control circuits		X	
-- cables		X	
- resistive electrical equipment		X	
-- heaters		X	
-- heat tracing		X	
- rotating equipment		X	
-- motors		X	
-- generators		X	
-- motor-generators		X	
- structural and auxiliary equipment		X	
-- hoists and cranes		X	
-- fire barriers		X	
-- electric boilers		X	
-- elevators		X	
- valve actuators		X	
-- manual operation		X	
-- testing		X	
-- position indication		X	
-- environmental impact		X	

Explain detailed construction and use of the following:		X	
- battery systems		X	
- cathodic protection systems		X	
- electrical distribution, including alternating and direct current systems		X	
- emergency power systems		X	
- generator excitation and control systems		X	
- protective relaying systems		X	
- reactor protection and containment isolation systems		X	
- station heat tracing systems		X	
- systems that include large motors such as circulating water, service water		X	
- transformer systems and auxiliaries		X	
- other systems import to plant operations such as those covered by technical specifications		X	
Perform the following specialized tasks		X	
- breaker operation, setting, adjustment and repair		X	
- motor-operated valve diagnostic testing		X	
- motor overhauls		X	
- high potential ("hi-pot") tests		X	
- stress relief of major components		X	
- high voltage connection preparation		X	
- relay setting, adjustment, calibration and repair		X	
- special soldering		X	
- tempering and annealing		X	
- battery load testing		X	
Describe the following:			
- advanced electronics theory, including operational amplifiers, integrated circuits and solid state circuitry			X

- digital electronics, including the different type of logics used and methods for programming and controlling circuit timing			X
- electrical circuit and instrument loop schematics			X
- pneumatic and hydraulic valve operator fundamentals			X
- principles of operation for the following types of radiation detectors:			X
-- Geiger-Mueller tube			X
-- scintillation detectors			X
- principles of operation of on-line chemistry instrumentation			X
- process measurement systems for pressure, temperature, flow, level and vibration			X
- process control; loop tuning and control fundamentals			X
Diagnose problems and perform maintenance on the following components			X
- electronic equipment			X
-- computers/microprocessors			X
-- analyzers			X
-- signal converters			X
- electrical components			X
-- power supplies			X
-- transformers			X
-- breakers			X
-- relays			X
- fire barriers			X
- hoists and cranes			X
- instrumentation components, including problems associated with placing components into or out of service			X
-- sensors and detectors			X
-- transmitters and indicators			X
-- recorders and annunciators			X

-- controllers and positioners			X
- structural and auxiliary equipment			X
- valve actuators			X
-- manual operations			X
-- alignment for remote control and/or automatic operation			X
-- testing			X
-- position indication			X
-- impact of environmental conditions			X
Describe the following:			X
- emergency core cooling systems including actuation instrumentation			X
- extraction steam control systems			X
- fire protection systems			X
- feedwater control systems			X
- instrument air systems, including major pneumatically-operated components			X
- neutron monitoring systems			X
- reactor protection systems			X
- turbine instrumentation and control systems			X
- other engineered safeguards instrumentation systems such as the containment isolation systems			X
- other systems important to plant operations such as those covered by the technical specifications			X
Troubleshoot and repair the following systems and equipment			X
- analytical equipment			X
- circuit boards			X
- computers			X
- turbine control system			X
- variable-speed pump controls			X

This product was partially funded by a grant awarded under the President's Community-Based Job Training Grants as implemented by the U.S. Department of Labor's Employment and Training Administration. The information contained in this product was created by a grantee organization and does not necessarily reflect the official position of the U.S. Department of Labor. All references to non-governmental companies or organizations, their services, products, or resources are offered for informational purposes and should not be construed as an endorsement by the Department of Labor. This product is copyrighted by the institution that created it and is intended for individual organizational, non-commercial use only.

Partial support for this work was provided by the National Science Foundation under grant number 0703169. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.