APPENDIX H

TRAINING ACCOMPLISHMENTS

A trainee, on completion of a 4-year of training program, should have the knowledge and hands-on skills in his/her trade as mentioned below:

H-1. ELECTRICIAN.

a. KNOWLEDGE

(1) Electrical Equipment. Familiar with theory, and working of various components of electrical machinery - windings, commutators, slip rings, wiring, insulation, power control circuits and other associated equipment. Must be capable of understanding electrical schematic diagrams and solid state circuits. Must be familiar with the principles of operation of protective relays, ground detection systems, remote control systems, excitation systems, measuring instruments, rectifiers, control circuits for motor operated disconnects, air circuit breakers, oil circuit breakers, transformers - power, potential & current, excitation systems, lighting arresters and H.V. arresters. Be familiar with National Electrical Code and its application and conformance to all jobs.

(2) Mechanical Equipment. Be familiar with the operating principles of hydraulic turbines, governors, water and oil pumps, lubrication systems, gantry cranes, heating, ventilating and air-conditioning (HVAC) systems, and other auxiliaries such as fishways and spillway machinery.

b. SKILLS

(1) Main Generator. Must be able to assemble/disassemble, repair and maintenance all components of the generator. Be familiar with the capacity, voltage and continuous output rating of the generator. Be able to start and stop the generator and set the reactive power before opening the generator breaker. Know operating and temperature limits of different components of the generator and adjust annunciation systems accordingly.

(2) Voltage Regulator. By using schematic diagram, be able to describe operation of voltage regulator (VR) and adjustments to system voltage. Know source of electric supply to VR, purpose and use of voltage adjusting rheostat and voltage regulator transfer switch.

(3) Exciter. Must know winding arrangements of pilot and main exciters, both rotating and solid state, and methods to control excitation current, purpose of excitation protective relays and how they are connected. Be able to draw a simple diagram showing the excitation system and generator field circuits.

(4) Transformer. Be familiar with all types of transformers (power, potential & current), function of transformers, winding arrangements, cooling arrangements, and control circuits. Be able to draw single line diagram and indicate various components of transformers and the way they are connected.

(5) Circuit Breakers. Be familiar with air and oil circuit breakers, the operating mechanism including arc extinction, D-C control circuits, breaker timer, and ratings.

(6) Protective Relays. Know different types of relays in the power plant, purpose of these relays and their operating and control mechanism, and resetting procedures.

(7) Disconnect Switches. Know operation of manual and motor operated disconnect (MOD) switches. Know the control circuit and key interlocks for MOD switches.

(8) Electrical Measuring Instruments. Must know all electrical measuring and test instruments, what they measure and when and where they are used.

(9) Turbine Governor. Be familiar with the operation of the turbine governor, understand the purpose of the speed sensing device of the governor to include maintenance and repair, and the speed setting of the governor. Be able to adjust limit switches, speed switches, and speed adjust motors.

(10) Air Conditioning, Heating, and ventilating Equipment. Know the working of main air handling unit and temperature control mechanism.

(11) Repair and Maintenance. Must know and recognize components of all electrical equipment in the powerhouse, be able to carry out inspections of all electrical equipment, disassemble and assemble them, repair, test, maintain, and where needed sent them for shop repairs outside the powerhouse. Be able to install rigid conduit, and pull wire and cable as necessary. Be able to record appropriate test data for comparison with future inspections and be able to calculate the rate of deterioration of equipment particularly insulation. Should be able to accomplish tripping tests during periodic inspections and routine maintenance. Be able to maintain and repair all annunciation systems.

(12) Safety and Clearances. Be able to work on all high/low voltage equipment without any harm to self or to others. Understand clearance purpose and procedure, recognize all protective cards, their purpose and use. Be able to clear out all electrical equipment and return them to service.

H-2. ELECTRONICS MECHANIC.

a. KNOWLEDGE

(1) Electronics and Electricity. Must know principles of electronics and electricity - resistors, capacitors, inductors, diodes, transistors, frequency bands, frequency resonance (parallel and series), rectification/inverting, voltage divider, gates, power supplies and charges, oscillator circuit, modulation, microwave transmitters and receivers, microwave channels, public address system, cables (Audio, Fiber Optic, Telephone etc.), basic television systems, radios (AM, FM & SSB), alarm systems (intrusion and system failure), microprocessors and microcomputers; multimeters/meters; relays and oscilloscopes.

(2) Miscellaneous. Be familiar with the working principles of electrical/mechanical equipment in the power plant such as electric generators/motors, pilot and main exciters, hydraulic turbines and governors, safety regulations and safe clearances procedures.

b. SKILLS

(1) Elementary Programming and Personal Computers. Be familiar with the standard software programs used in the power plant system. Be able to access and exit from these software packages. Be able to connect personal computers (PCS) together locally and remotely. Be able to use advanced and diagnostic software, including special applications.

(2) Antennas and Towers. Be able to calculate and check SWR or reflective power on antennas. Be able to establish a base station or a mobile unit with proper type of coax cable and antenna for a simplex/duplex system. Must be familiar with safety precautions to be taken and protective equipment required while working on or around the tower.

(3) Clearance Procedures. Must know who can authorize, issue, hold, and release a clearance. Know the proper use of Hold and Caution cards in the electronic, and lockout procedures. Know the safety requirements when working at a remote location performing routine, preventive, or breakdown maintenance. Know the electronics and electric circuitry in the powerhouse.

(4) Hand Tools. Know the purpose and use of the various air and electric tools and equipment such as soldering and de-soldering equipment, pencils, guns, wicks and suction; chassis punches; drills/taps; rivet tools; board pulling, insertion and cleaning; chip puller; transistors; radio components; cable connectors; wire wrap gun; shirk tubes/heat guns and other tools in the electronic shop. Be able to establish and check grounding for power tools.

(5) Oscillator Circuits. Be able to select and gather material for an oscillator circuit. Be able to build chassis , mount components, connect oscillators and test points for testing input and output.

(6) Test Equipment. Must be able to use multimeters that test more than one electrical quantity and measure values. Be able to connect leads, set switches and controls, and know the safety requirements when using these meters. Be able to use oscilloscope and interpret the screen display relating to voltage, frequency, distortion, and noise. Be able to use other test equipment such as digital storage oscilloscope, digital analyzer, logic probe, pulser, etc.

(7) Radio Installation, Vehicle. Be able to install a radio on a vehicle, know the location of different components to be installed in the vehicle, know the types of antennas used for different types of radios - mobile, portable, base, and repeater; be able to check and set modulation, and adjust frequency.

(8) Microwave Channel. Be able to establish a microwave channel. Know the channel capability of the microwave system, output amplifier, antenna, space diversity, frequency diversity, passive repeaters, base band measurements, type of tuned circuits used in the microwave frequency range, klystron, magnetron, and level settings for a two-wire and a four-wire circuit.

(9) Basic Television Systems, Closed Circuit TV. Know the operation of television surveillance systems, closed circuit TV, cameras and monitors.

(10) Alarm Systems. Be familiar with the various alarm systems mainly intrusion and system failure in the powerhouse. Know what systems have failure alarms, what and where are

the detection devices located that set off a failure alarm. Know the intrusion systems and the locations of detection devices that set off alarms and the actions to be taken when an alarm is actuated.

(11) Supervisory Controls. Must be familiar with the Supervisory Control and Data Acquisition (SCADA) system, communication links, modems, printers, storage devices, synchronous and asynchoronous controllers, microprocessors and microcomputers, software and hardware, assembler and compiler, RAM and ROM; and all event recording systems which are essential for production and control of electric power and flood control.

(12) Testing and Trouble Shooting. Be able to trace trouble points with the help of test equipment and prepare reports, as needed on the faulty equipment.

(13) Maintenance and Repair of Electronic Equipment. Be able to maintains in good working condition all shop and field electronic equipment by timely repair, test and calibration. Maintain maintenance records for individual equipment.

H-3. MECHANIC.

a. KNOWLEDGE

(1) Mechanical Equipment. Know working principles and components of all mechanical machinery and equipment in the powerhouse. It includes hydraulic turbines, governors, cooling systems, air compressors, pumps - water, lubricating; heating, ventilating and air conditioning (HVAC) systems; flood gates, cranes and hoists, machinery in machine shop, acetylene and electric welding equipment.

(2) Electrical Equipment. Know basic principles of electrical machinery, generator - rotor & stator, pilot & main exciters, transformers, circuit breakers, disconnects, and annunciation systems.

b. SKILLS

(1) Hydraulic Turbines. Know and recognize all components of turbines installed in the powerhouse, types of lubricants and the method to lubricate various components such as wicket gates, arms and operating ring. Be able to disassemble, repair, and assemble packing glands. Know location and type of temperature detectors used in the turbine guide, generator guide and generator thrust bearing, their maximum safe operating temperature, cooling systems, and corrective actions if the temperature exceeds those limits. Understand oil flow systems e.g., high lift systems for thrust bearing.

(2) Governors. Know all components of the governor and how they influence operation of the turbine. Know the construction and operation of the generator overspeed mechanism, ratio of speed between flyballs and main shaft, control mechanism of main valve and pilot valve, and opening and closing of wicket gates. Be familiar with the pressure range of the governor, gate limit device, shutdown solenoid, governor oil pumps and method of priming them, speed droop mechanism, function of the compensating mechanism, main relay valve, float operated valve in the governor oil pressure tank, and corrective action to restore a unit to service following a low oil pressure shutdown.

(3) Air Compressors. Be familiar with the working, control, and lubrication of station air compressor and governor air compressor. Know the operating pressure of the generator brake system, be able to jack a unit and return the brakes to normal. Know the tail water depression system, its components and operation.

(4) Heating, ventilating and air conditioning. Be familiar with the air treatment systems, their location in the powerhouse and areas they furnish treated air; working of air conditioning unit and water chilling unit; filtering system used for the ventilating fans; operation and purpose of the heaters used in the generator housing and the generator air cooling system.

(5) Pumps and Pipe-fitting. Know location, purpose, components and operation of all pumps in the powerhouse, use of different types of valves, installation of packing rings, making screwed pipe joints and incidental repair/maintenance work involved with pumps and pipes.

(6) Machine Shop. Know all machinery in the Machine Shop, its operation and use. Be able to accomplish jobs on the lathe, band saw, drill press, milling machine, and other machinery.

(7) Welding. Know the use of acetylene and electric welding equipment, use of flux in welding and purpose of wearing a shield when welding. Be able to repair/weld cavitation damage in addition to other common jobs.

(8) Water Systems. Be familiar with the various water systems used in the power plant, such as raw water system, turbine unwatering system, generator stator cooling system, generator and turbine bearing cooling systems, water purification and sewage treatment systems. Be able to operate and maintain these systems.

(9) Fire Fighting Equipment. Know types of fires and the equipment and chemicals required to extinguish each type. Be aware of precautions to be taken for safety to human life when using fire extinguisher, and procedure for reporting fire alarms in the powerhouse.

(10) Safety and Clearance Procedure. Must be familiar with the safety rules and regulations pertaining to power plants and be able to take adequate precautions while working on different jobs such as welding, grinding, cleaning generator shaft with the unit in motion, working in the wheel pit of a machine, painting or cleaning with paint thinning solutions, and use of breathing equipment. Know the precautions to be taken to avoid contact with the live electric current. Recognize safety hazards of moving equipment; compressed air, gas, and liquids; electric shocks; flying particles, dust, dirt and fumes; and working in contained spaces. Know and recognize all clearance cards and purpose of each card, responsibilities of the person receiving a clearance, and actions for clearing in and clearing out. Understand why it is necessary to follow a switching order in the exact order in which it is written.

(11) Elements of Rigging. Understand and be able to accomplish things like splicing and seizing hemp and wire ropes. Be able to handle and use wire ropes in a safe manner, determine the safe load capacity of a hook, mechanical advantage of block and tackle in handling heavy loads, use of shackles and rope clips and their applications. Should be able to define and use choker, double-bridge slings, thimble, open and closed sockets, and spelter sockets.

(12) Maintenance and Repair of Mechanical Equipment. Be able to maintain, repair, adjust, and lubricate mechanical features of generators and motors, turbines and pumps,

governors, overhead or gantry cranes, high pressure CO2 systems, HVAC systems, elevators, sluices and spillway gate hoists with cables or chains, machine shop tools, water treatment and waste disposal plants, oil storage and purification systems, automatic and manual fire extinguishing equipment; mechanical, pneumatic and hydraulic controls, and other mechanical features of the power project. Must be able to diagnose mechanical failures of equipment and perform repairs as needed on all mechanical operating equipment of the powerhouse, dam, and intake structures. Be able to test repaired equipment to assure proper performance.

H-4. OPERATOR.

a. KNOWLEDGE

(1) Electrical Equipment. Be familiar with the working principles of AC and DC motors and generators, exciters, voltage regulators, circuit breakers, transformers, switches, and relays.

(2) Mechanical Equipment. Be familiar with the working principles of water turbines, governors, water and air pumps, lubrication systems, heating and cooling systems. Be familiar with the structural and mechanical features of dam, intake structures, and spillways.

b. SKILLS

(1) Hydropower Unit. Able to start and connect a unit to the power system, know setting of reactive power and actions to be taken to control runaway speed of the unit. Be able to coordinate operation of power plant and dam to satisfy flood control, stream flow, power contract commitments, and other requirements. Be able to take appropriate actions to restore power after interruptions, remove faulty equipment from service, and provide computer input and update of all data associated with the operation of the generating units.

(2) Generator. Know and recognize all components of the generator, its rating and operating and maximum temperature limits.

(3) Exciter. Be able to control and monitor pilot and main exciters.

(4) Voltage Regulator. Know components and working of various kinds of voltage regulators and be able to control voltage through the use of voltage rheostat.

(5) Transformers. Know and recognize all types of transformers - power, potential and current. Recognize alarms on transformers, what causes them and actions to be taken on receiving the alarms.

(6) Circuit Breakers. Understand control circuits, and be able to operate all circuit breakers - oil & air, by remote or manual control.

(7) Relays. Know all relays used in power plant, reasons for relay trips and how to reset them.

(8) Disconnect Switches. Be able to operate all switches - motor operated or manual, without harm to self or others.

(9) Turbines. Be familiar with different types of turbines, and be able to operate servo motors, wicket gates, and other auxiliaries.

(10) Governors. Be familiar with various components of the governor - actuator, pumps, permanent magnet generator, and corrective actions on low generator oil pressures.

(11) Interlocks. Be able to accomplish electrical and mechanical interlocks pertaining to generators, circuit breakers, disconnect switches, metal clad switchgear, relays and governors.

(12) Instruments and metering. Know purpose and use of all meters and be able to read them correctly.

(13) Annunciation Systems. Know types and main features of all annunciation systems and actions to be taken on receiving an annunciation. Know what each alarm means and where the individual alarm reading units are. Be able to recognize degree of urgency to each alarm and allocate resources and attention accordingly.

(14) Clearance Procedure. Be able to issue clearances both electrical and mechanical on all major equipment under the "Safety Clearance Procedure" ER 385-1-31. Know the purpose and use of protective card - when and where, and procedure for clearing out. Be able to use electrical and mechanical drawings in the performance of switching and operating procedures.

(15) Water Systems. Know all water systems in the power plant - raw water, potable water, unit unwatering system, generator stator coils and bearing cooling water systems.

(16) Storage Batteries and Charges. Know type of storage batteries and charges in the powerhouse, D-C circuits and how batteries are connected to the D-C bus.

(17) Heating and Ventilating Systems. Know how to operate heating and ventilating systems and control the temperature.

(18) Station Service. Know both AC and DC systems for normal and emergency source of power, and operation and utilization of emergency power.

(19) Record Keeping. Be able to prepare records such as daily log of important events, periodic summaries of water control operations, pool and tailwater elevations, energy and capacity deliveries, weather, equipment failures, outage and operating time. Be able to calculate from tables and meters the water inflow, water discharge through turbines and gates, and reservoir volume.