



Plant Maintenance
Electrical/Instrumentation Technologist

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Agenda

1. Work Habits
2. Safety
3. Electrical
4. Instrumentation
5. Tools & Equipment
6. Open Discussion



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How do I pass?

1. Study Materials
2. Math
3. Definitions
4. Common Abbreviations



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A horizontal collage of four images: a transformer diagram with labels 'PRIMARY', 'SECONDARY', 'MOVEABLE TAP', 'P', 'A', 'B', 'E', 'S'; a worker with a 'NOT OPERATE EQUIPMENT LOCKED OUT' sign; a worker in a hard hat working on a panel; and a large electrical control cabinet.

Work Habits

A small circular logo in the bottom right corner of the slide, featuring a stylized 'S' and the text 'SOUTHERN CALIFORNIA ELECTRICITY TRAINING CENTER'.

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Skill Set 1 – Work Habits

1. Receiving job instruction and planning equipment use are part of:
 - a. Craft data
 - b. Job preparation ✓
 - c. Work factors
 - d. Leveled time

2. Anticipating other tasks or problems:
 - a. Usually creates additional problems
 - b. Wastes time
 - c. Sharply reduces the number of emergencies ✓
 - d. Often is not worth the effort

3. Making job planning a group effort:
 - a. Wastes time
 - b. Improves productivity ✓
 - c. Causes confusion
 - d. All the above



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The collage consists of three distinct images. On the left is a technical diagram of a transformer with labels for 'PRIMARY', 'SECONDARY', and 'MOVEABLE TAP', and terminals 'P', 'A', 'B', and 'E_S'. In the center is a photograph of a worker in a white hard hat and safety glasses, holding a large white sign that reads 'NOT OPERATE EQUIPMENT LOCKED OUT'. On the right is a photograph of an industrial control room or panel with various gauges, switches, and wiring.

Safety



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Skill Set 2 – Safety

Discuss the major categories of hazards a worker may encounter when entering a confined space at a wastewater treatment plant or in a sewer or lift station:

- Atmospheric
 - Physical injury
 - Infection and disease
 - Insect and vermin bites
 - Toxic exposure
 - Drowning
1. What is always required when working in a confined space?
 - a. Use of self-contained breathing apparatus
 - b. Continuous air monitoring ✓
 - c. Continuous ventilation
 - d. Use of tripod hoist and harness
 2. Oxygen deficiency occurs when the oxygen level is less than ____ by volume
 - a. 1.5%
 - b. 10.0%
 - c. 19.5% ✓
 - d. 21.0%



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Skill Set 2 – Safety

3. The NEC identifies environments that contain flammable vapors and gases as which class of hazardous locations?
 - a. Class III
 - b. Class II
 - c. Class I ✓
 - d. Class IV
4. Which of the following reduces high voltages and currents to safe values for measurements?
 - a. Auto transformer
 - b. Megohmmeter
 - c. Instrument transformer ✓
 - d. Variable transformer
5. On a MSDS the section that gives the safe exposure limits, based on OSHA guidelines, is:
 - a. Chemical identity
 - b. Control measures
 - c. Safety precautions
 - d. Hazardous information and ingredients ✓



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Skill Set 2 – Safety

1. Rubber safety gloves should be tested how often?
 - a. Every 12 months
 - b. Every 9 months
 - c. Every 6 months ✓
 - d. Every 4 months

2. Rubber safety blankets should be tested how often?
 - a. Every 6 months
 - b. Every 12 months ✓
 - c. Every 9 months
 - d. Every 18 months

3. What is the interrupting current of a GFIC receptacle?
 - a. 20 VAL
 - b. 5-6 MA ✓
 - c. 10 UDL
 - d. 10 MA



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Skill Set 2 – Safety

4. What type of stepladder is forbidden while working on electrical equipment?
 - a. Wood
 - b. Fiberglass
 - c. Aluminum ✓
 - d. Ceramic

5. What is the killer of electrical shock?
 - a. Voltage
 - b. Current ✓
 - c. Resistance
 - d. Ohms




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Electrical



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Skill Set 3 – Electrical

Important Terms to Know and Understand:

1. **Power source:** provides the electromotive force to drive current (move electrons) through the circuit conductors.
2. **Resistors:** provide resistance to the flow of current through these components
3. **Capacitors:** energy storage components that take and retain a charge
4. **Solenoid switch:** an electromechanical device that can be actuated by applying an electrical current
5. **Transformer:** a device for stepping up or stepping down voltage. It utilizes a pair of coils with different numbers of windings. Current flowing through one coil induces current in the adjacent coil.

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Skill Set 3 – Electrical

1. The relationship between an electric current and a magnetic field is called:
 - a. Matter
 - b. Atoms
 - c. Electromagnetism ✓
 - d. Element
2. An on-off switch with overload relays is called a:
 - a. Magnetic starter
 - b. Manual starter ✓
 - c. Reversing starter
 - d. Combination starter
3. The amount of potential difference a layer of insulation can withstand without breaking down is called:
 - a. Resistance
 - b. Voltage drop
 - c. Dielectric strength ✓
 - d. Ampacity

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Skill Set 3 – Electrical

4. What is the name of the property of a coil of wire that opposes any change in the current in the coil?
 - a. Inductance ✓
 - b. Resistance
 - c. Impedance
 - d. Watts
5. What device changes alternating current to a different combination of potential difference and current?
 - a. Generator
 - b. Capacitor
 - c. Alternator
 - d. Transformer ✓
6. How does the power going into a transformer compare to the power coming out?
 - a. Lower
 - b. Equal ✓
 - c. Double
 - d. Higher



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Skill Set 3 – Electrical

7. In a three-wire control circuit, when a power failure occurs:
 - a. The interlock contact will close the circuit
 - b. The operator can restart the motor automatically
 - c. The motor can restart unexpectedly
 - d. The operator must restart the motor manually ✓

8. Shielding protects an analog meter from:
 - a. Damage due to careless handling
 - b. Harmful UV rays
 - c. Over-current and surges
 - d. Stray magnetic fields ✓

9. An ammeter should be connected:
 - a. Across the line
 - b. Around an inductor
 - c. In parallel with the load
 - d. In series with the load ✓

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Skill Set 3 – Electrical

1. The frame, the core, the winding, and the end plates are all parts of the:
 - a. Rotor
 - b. Stator ✓
 - c. Alternator
 - d. Induction motor

2. Two sources of power, one AC and one DC, are required for running a(n):
 - a. Induction motor
 - b. Squirrel-cage motor
 - c. Synchronous motor ✓
 - d. Wound-rotor motor

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Skill Set 3 – Electrical

7. A wet well measures 30 feet deep, 25 feet wide and 35 feet long. What is the capacity in gallons?
 - a. 3,509,000 gal
 - b. 19,635,000 gal
 - c. 26,250,000 gal
 - d. 196,350 gal ✓

8. What is the amp-load of a three-phase, 0.5-hp, 230-volt motor with an efficiency rating of 92% and a power factor of 80%?
 - a. 1.27 amps ✓
 - b. 1.19 amps
 - c. 2.55 amps
 - d. 4.41 amps

9. A three-phase, 460-volt motor draws a current of 52 amperes. The motor has an efficiency rating of 94% and a power factor of 80%. What is the horsepower?
 - a. 24.1 hp
 - b. 41.7 hp ✓
 - c. 50.0 hp
 - d. 73.8 hp



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Skill Set 3 – Electrical

1. Which of the following wiring methods is not approved for use in Class I, Division I locations:
 - a. Rigid conduit
 - b. Steel IMC conduit
 - c. Electrical metallic tubing ✓
 - d. Type MI cable with proper termination fittings

2. Electrons flowing from one place to another make?:
 - a. Current ✓
 - b. Track
 - c. Circuit
 - d. Channel

3. Between two objects, the development of static charges creates a:
 - a. Potential difference ✓
 - b. Battery
 - c. Thermocouple
 - d. Resistance



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Skill Set 3 – Electrical

4. Magnetic starters are designed to allow what % FLC?:
 - a. 85
 - b. 115
 - c. 125 ✓
 - d. 100

5. Metals are good conductors because they have many:
 - a. Insulators
 - b. Free electrons ✓
 - c. Resistors
 - d. Inductors

6. The main reason for wire insulation failure is:
 - a. Heat, Moisture and Dirt ✓
 - b. Wrong application
 - c. Failure to test
 - d. Water damage



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Skill Set 3 – Electrical

10. What is the most important feature for adequate equipment grounding?
 - a. Insulation
 - b. Low-impedance path ✓
 - c. Low current
 - d. Over-current devices

11. What is the unit of measurement for capacitive reactance?
 - a. Volts
 - b. Ohms ✓
 - c. Amps
 - d. Power factor

12. Power companies use AC generators instead of DC generators because AC can be sent over long distances:
 - a. At high cost
 - b. At low cost ✓
 - c. Slower
 - d. Faster



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Skill Set 3 – Electrical

13. The National Electrical Code defines a qualified person as someone who?
 - a. Has been on the job one year.
 - b. Is a supervisor or manager.
 - c. Is certified by a testing laboratory.
 - d. Is familiar with equipment operations and hazards. ✓

14. The insulation in a capacitor is called?
 - a. Condenser
 - b. Farad
 - c. Dielectric ✓
 - d. Higher

15. What kinds of bearings are used when a motor is to be mounted horizontally?
 - a. Radial ✓
 - b. Thrust
 - c. Angular
 - d. Antifriction



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Skill Set 3 – Electrical

28. Many maintenance organizations are implementing predictive maintenance programs. Predictive maintenance may best be described as?
 - a. Predicting equipment failures using high tech equipment such as vibration analysis and infrared detection.
 - b. Using observed information to predict the life expectancy of a particular type of equipment and replace or rebuild just prior to expected failure.
 - c. Taking measurements on equipment under operating conditions in order to detect symptoms that are not in line with predetermined parameters and classify the causes. ✓
 - d. Using machinery history to predict the maintenance required.



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Electrical Checklist

1. What is the proper way to test motor insulation?
2. Who many Watts in one horsepower?
3. How do we size a motor?
4. What is a balanced power system?
5. What is grounded vs. grounding?
6. Electrical Questions????



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Instrumentation



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Skill Set 4 – Instrumentation

Case study: You receive a trouble call that the magnetic flow meter for a centrifugal pump is not operating properly. When you arrive to inspect the pump, instrumentation on the control panel indicates that the electric motor is receiving power and that the pump discharge pressure and flow are zero. Discuss possible problems and the diagnostic approach to take.

1. Determine whether motor is turning or not
2. Determine whether pump shaft is turning or not
3. Determine if valves on the suction and discharge piping are open or closed
4. Check to see if pump casing is hot (indicates spinning pump with no water flow)
5. Check to see if a pressure gauge is installed and whether it reads positive pressure.
6. Check to see if water is flowing and instrumentation is faulty.
7. Check for 4 – 20 ma signals from the mag-meter and pressure sensor loops.



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Skill Set 4 – Instrumentation

1. Offset is the difference between the actual maintained value of the measured variable and:
 - a. The set point ✓
 - b. The span
 - c. Zero
 - d. The level
2. Another name for built-in error that usually occurs in a proportional control system is:
 - a. Deadband
 - b. Offset ✓
 - c. Set point
 - d. Span
3. An automatic controller always compares a measured variable to:
 - a. Zero
 - b. Span
 - c. Reset
 - d. Set point ✓



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Skill Set 4 – Instrumentation

4. The drawing that provides a view of the entire system in process control is the:
 - a. P&ID drawing ✓
 - b. I/P drawing
 - c. Element drawing
 - d. Primary drawing

5. Name the three most common mediums of data transmission.
 - a. Twisted pair, radio, fiber optics ✓
 - b. Phone, telemetry, radio
 - c. Cable, phone, radio
 - d. Coax, phone, fiber optics

6. The abbreviation SCADA stands for:
 - a. Safety Control and Data Answering
 - b. Supervisory Control and Data Acquisition ✓
 - c. System Computer and Digital Analog
 - d. Self Contained and Data Acquisition



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Skill Set 4 – Instrumentation

7. The RS232C standard applies to what type of digital transmission?
 - a. Balanced
 - b. Fiber Optic
 - c. Parallel
 - d. Serial ✓

8. Where is a computer's start-up program usually stored?
 - a. In RAM
 - b. In ROM ✓
 - c. On disk
 - d. On magnetic tape



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Skill Set 4 – Instrumentation

4. A CDU (command and display unit) computer screen that senses finger pressure is:
 - a. A digitizer
 - b. An intelligent terminal
 - c. A scanner
 - d. A touch screen ✓

5. To simulate an RTD input, you use a:
 - a. Digital VOM
 - b. Potentiometer
 - c. Resistance decade box ✓
 - d. Wally box

6. The specific value at which an automatic control holds a process variable is called the:
 - a. Span
 - b. Variable
 - c. Control point ✓
 - d. Set point



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Skill Set 4 – Instrumentation

10. A signal from a measuring device to the controller is called:
 - a. Zero
 - b. Correcting
 - c. Span
 - d. Feedback ✓

11. In a closed loop control system, the control process of measuring, comparing, computing and connecting goes on:
 - a. Continually ✓
 - b. Intermittently
 - c. Never
 - d. Whenever the operator takes some action

12. A control system in which the output is regulated only by changes from the outside the process is called:
 - a. Open loop ✓
 - b. Closed loop
 - c. Set point
 - d. Measuring



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Skill Set 4 – Instrumentation

13. A common converter used in process control is the I/P converter, which converts _____ signals to _____ signals.
- Zero, span
 - Analog, digital
 - Current, pneumatic ✓
 - Linear, nonlinear
14. Time lag can be defined as the time between:
- Turning an instrument on and off
 - A high reading a low reading
 - A proportional reading, and an inverse reading
 - Input to an instrument and output from an instrument ✓
15. Local I/O expansion involves the addition of:
- A second processor
 - A shift register
 - Data-handling capabilities
 - I/O points within the rack ✓



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Skill Set 4 – Instrumentation

22. A computer program operates under the control of a(n):
- Operating system
 - Controller system
 - Interface system ✓
 - Process system
23. The configuration in which individual computers are connected for the purpose of communication is a:
- CPU
 - BIU
 - Network ✓
 - Loop
24. The abbreviation LAN stands for:
- Level Alarm Network
 - Loop Alarm Neutral
 - Local Alarm Network
 - Local Area Network ✓



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Skill Set 4 – Instrumentation

25. Whole circuits manufactured with all components in place and ready to work are called:
- a. Semiconductor circuits
 - b. Microprocessor circuits
 - c. Rectifier circuits
 - d. Integrated circuits ✓
26. What is the psi if the height of a column of water is 55.4 inches?
- a. 2 psi ✓
 - b. 4.1 psi
 - c. 27 psi
 - d. 55.4 psi



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Skill Set 4 – Instrumentation

27. A circle has a circumference of 393 feet. What is the diameter?
- a. 63 feet
 - b. 98 feet
 - c. 125 feet ✓
 - d. 197 feet
28. 77°F is equal to how many degrees Celsius?
- a. 81°C
 - b. 60°C
 - c. 43°C
 - d. 25°C ✓



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Instrumentation Checklist

1. What is Process?
2. What is a Control Loop?
3. What is a Transducer?
4. What is Process measurement?
5. What is a Transmitter?
6. Instrumentation Questions ??????



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Tools & Equipment



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Skill Set 5 – Tools & Equipment

Technologists spend a good portion of their workday using tools. Using the proper tool for a job can make that job immeasurably easier. Using a tool properly can assure a quality job and can prevent personal injury and damage to equipment. Initiate a discussion of the types of functions they need to perform as technologists and the tools that they can use to perform those functions.

Important terms to know and understand:

1. **Measuring:** volt meters, amp meters, meggers, circuit testers, and loop calibrators.
2. **Pipefitting:** tube benders and cutters, and conduit benders.
3. **Electrical:** knockout punches, fish tape, various special pliers, circuit testers, meggers, multi-meters, and amp meters.
4. **Hoisting/Pulling:** rope, wire rope, slings, sling hitches, and block and tackle.



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Skill Set 5 – Tools & Equipment

1. When working with electricity, it is especially important to inspect tools for:
 - a. Bent shafts
 - b. Cracked handles
 - c. Damaged insulation ✓
 - d. Work tips
2. When a Flow meter does not read properly, check:
 - a. Power to a circuit
 - b. Primary element
 - c. Transmitter and receiver
 - d. All the above ✓



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Skill Set 5 – Tools & Equipment

3. What Category rating on a meter would be used on service drop?
 - a. Cat. 4 ✓
 - b. Cat. 2
 - c. Cat. 3
 - d. Cat. 1

4. What Category rating on a meter would be used on protected electronic equipment?
 - a. Cat. 2
 - b. Cat. 1 ✓
 - c. Cat. 3
 - d. Cat. 4



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Skill Set 5 – Tools & Equipment

1. The supply of spare parts, tools, and test instruments should be monitored by the:
 - a. Supervisory control operation
 - b. Limited control operation
 - c. Computer control operation
 - d. Inventory control operation ✓

2. Which of the following is the best choice of work clothing fabric when working with electricity?
 - a. Cotton
 - b. Nomex ✓
 - c. Nylon
 - d. Polyester

3. The best combination of gloves to wear when performing electrical work is:
 - a. Leather over rubber ✓
 - b. Leather over cotton
 - c. Synthetic over rubber
 - d. Synthetic over cotton



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Skill Set 5 – Tools & Equipment

4. Which of the following is a function of the tag and lockout disconnect switch?
 - a. Give instructions for the work to be performed
 - b. Identify the individual who placed the lock ✓
 - c. List all affected sub systems
 - d. Prevent accidental startup

5. What is the best protection against the risk of infections and infectious diseases:
 - a. Immunization program
 - b. PPE
 - c. Personal hygiene ✓
 - d. Safety courses



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Skill Set 5 – Tools & Equipment

6. The basic elements of a hazard communication program are:
 - a. Identify hazardous materials
 - b. Chemical info and hazardous conditions
 - c. Labels and training
 - d. All of the above ✓

7. What is the main hazard associated with electrical energy?
 - a. Touch potential
 - b. Step potential
 - c. Blast, Arc, Shock ✓
 - d. Bolted fault current



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General Information

1. The Power system electrical components are:
2. The Source Power- PG&E
3. The Power System- Main Fuse box
4. The Control System- Floats/Switches



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General Information

1. NFPA 70E is the Standard for Electrical Safety in the Workplace
2. NFPA 70B is the Recommended Practice for Electrical Equipment Maintenance
3. NFPA 79 is the Electrical Standard for Industrial Machinery
4. NFPA 70 is the Electrical Code



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General Information

1. Remember to think about prior years
2. Most questions based on last years info.
3. Use the study guides
4. Study your Math
5. Study in a group



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Open Discussion

Be Ready, Study!
Good Luck!



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