

**Study Guide
for
Instrument Technician**

Test No. 2704

**Performance Assessment Services
Southern California Edison Company**

REV 121002

Introduction

The Instrument Technician Test is a job knowledge test designed to cover the major knowledge necessary to perform the job. This *Guide* contains strategies to use for taking tests and a study outline, which includes knowledge categories, major job activities, and study references.

Test Scheduling

Employees who apply for positions, bids, and transfers requiring testing before March 9, 2009, will be scheduled for testing by their Supervisor through Human Resources. For those who apply after March 9, 2009, both the employee and their Supervisor will be notified of a scheduled test date by Human Resources. Test times and dates for positions requiring testing will be specified in the bid/transfer/requisition/job posting. Employees should be prepared to test on the specified dates. Only employees who apply for positions requiring testing, and who meet basic qualifications, will be invited to test. Applicants will be scheduled through the recruiter. If you have any questions, please call 626-302-9830.

Test Session

It is important that you follow the directions of the Test Administrator *exactly*. If you have any questions about the testing session, be sure to ask the Test Administrator before the testing begins. During testing, you may not leave the room, talk, smoke, eat, or drink. Since some tests take several hours, you should consider these factors before the test begins.

All questions on this test are multiple-choice with four possible answers. Prior to March 9, 2009, your answers to the questions are indicated by filling in a circle on an answer sheet with a special mark-sense pencil. For your answers to be read accurately by the scanner, you must fill in the circles completely and erase completely any answer you wish to change. After March 9, 2009 you will take the exam on a computer. For more information on this, please see the next section of this study guide, Computer Based Testing.

The test is in two parts, each part has a two and a half hour time limit, and you may use a non-programmable calculator. **Calculators will be provided by the Test Administrator, and will be one of the following three models: Casio fx-250HC, Texas Instruments TI-30XA, TI 36-X.**

You will receive a Test Comment form so that you can make comments about test questions. Write any comments you have and turn it in with your test when you are done.

Study Guide Feedback

At the end of this *Guide* you have been provided with a Study Guide Feedback page. If a procedure or policy has changed, making any part of this *Guide* incorrect, your feedback would be appreciated so that corrections can be made.

Computer Based Testing

Effective **March 9, 2009**, all knowledge tests will be administered on the computer. This information will help prepare you for a knowledge test taken on or after **March 9, 2009**.

Taking an SCE knowledge test on the computer is simple. You do not need any computer experience or typing skills. You will only use the keyboard to enter your candidate ID and password. You'll answer all questions by pressing a single button on the mouse.

Log in Screen

You will be seated at a testing station. When you are seated, the computer will prompt you to enter the candidate ID and password you received in your invitation e-mail. You **MUST** have your candidate ID and password or you will be unable to take the test. Once you have confirmed your identity by entering this information, you will see a list of tests available to you.

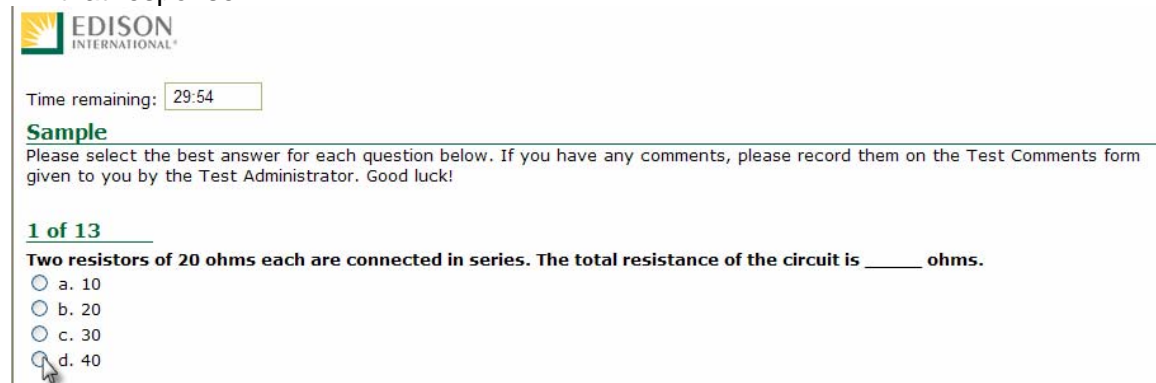
Sample/Tutorial

Before you start your actual test, a Sample/Tutorial Test is provided to help you become familiar with the computer and the mouse. From the list of exams that appear when you complete the log in, you will select Sample/Tutorial. You will have up to 10 minutes to take the Sample/Tutorial Test. The time you spend on this Sample Test DOES NOT count toward your examination time. Sample questions are included so that you may practice answering questions. In the Sample/Tutorial Test, you will get feedback on your answers. You will not receive feedback on your actual test.

Example

During the test, to answer each question, you should move the mouse pointer over the circle (radio button) next to the answer of your choice, and click the left mouse button. The amount of time you have remaining to take the test will always be shown in the top left corner of the screen. A sample is show below:

1. When you begin the test, you can see the total time allowed for completion displayed at the top of the screen. You can scroll up to see that information at any time during the test.
2. In order to answer each question, first read the question and determine the response that best answers the question. Put the mouse pointer directly over the circle corresponding to that response.



The screenshot shows the Edison International test interface. At the top left is the Edison International logo. Below it, a timer displays "Time remaining: 29:54". A section titled "Sample" contains the instruction: "Please select the best answer for each question below. If you have any comments, please record them on the Test Comments form given to you by the Test Administrator. Good luck!". Below this, it says "1 of 13". The question is: "Two resistors of 20 ohms each are connected in series. The total resistance of the circuit is _____ ohms." The options are: a. 10, b. 20, c. 30, and d. 40. A mouse cursor is pointing at the radio button for option d.

3. While the pointer is over the circle corresponding to the best answer, click the left mouse button.



Click the left button when the pointer icon is over your answer choice.

- The answer you selected should now have a green dot in the circle. If you need to select an alternate answer, simply move the pointer over that circle, and click again.



Time remaining:

Sample

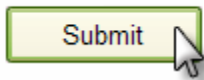
Please select the best answer for each question below. If you have any comments, please record them on the Test Comments form given to you by the Test Administrator. Good luck!

1 of 13

Two resistors of 20 ohms each are connected in series. The total resistance of the circuit is _____ ohms.

- a. 10
- b. 20
- c. 30
- d. 40

- You can change your answers at any time during the test until the time runs out, or you click the "Submit" button.



Test Taking Strategies

Introduction

The Instrument Technician Test contains multiple-choice questions. The purpose of this section is to help you to identify some special features of a multiple-choice test and to suggest techniques for you to use when taking one.

Your emotional and physical state during the test may determine whether you are prepared to do your best. The following list provides common sense techniques you can use before the test begins.

Technique

Remarks

Be confident

- If you feel confident about passing the test, you may lose some of your anxiety.
- Think of the test as a way of demonstrating how much you know, the skills you can apply, the problems you can solve, and your good judgment capabilities.

Be punctual

- Arrive early enough to feel relaxed and comfortable before the test begins.

Concentrate

- Try to block out all distractions and concentrate only on the test. You will not only finish faster but you will reduce your chances of making careless mistakes.
- If possible, select a seat away from others who might be distracting.
- If lighting in the room is poor, sit under a light fixture.
- If the test room becomes noisy or there are other distractions or irregularities, mention them to the Test Administrator *immediately*.

Budget your time

- Pace yourself carefully to ensure that you will have enough time to complete all items and review your answers.

Read critically

- Read all directions and questions carefully.

- Even though the first or second answer choice looks good, be sure to read all the choices before selecting your answer.

Make educated guesses

- Make an educated guess if you do not know the answer or if you are unsure of it.

Changing answers

- If you need to change an answer, be sure to erase your previous answer completely. On the computer, be sure that the new answer is selected instead of the old one.

Return to difficult questions

- If particular questions seem difficult to understand, make a note of them, continue with the test and return to them later.

Double-check mathematical calculations

- Use scratch paper to double check your mathematical calculations.

Review

- If time permits, review your answers.
- Do the questions you skipped previously.
- Make sure each answer bubble is *completely* filled in. Erase any stray marks on your answer sheet. When testing on the computer, make sure each question has a green dot next to the correct answer.

Remember the techniques described in this section are only suggestions. You should follow the test taking methods that work best for you.

Study Guide Outline

Job Knowledge Categories

Below are the major job knowledge categories that are covered on the test.

A. Pneumatics and Control Theory

Involves the principles of closed loop, analog, and digital control as applied to process (temperature, pressure, flow, level) control and the theory of operation of pneumatic amplifiers and analog measuring devices.

B. Electrical and Electronic Theory

Includes AC and DC theory involving Ohm's law, series and parallel circuits, inductance, capacitance, resistance, etc., wiring and circuit diagrams, electrical and electronic symbols and terminology, electronic circuitry, solid state theory and knowledge of transistors, digital logic and microprocessor basics, as well as Wheatstone Bridge.

C. Equipment Knowledge

Refers to the nomenclature, function, and operating principles of steam generating station instrumentation including indicators, recorders, transmitters, controllers and all related control system equipment, including valves, pressure temperature, and level switches, thermocouples, tubing, and all other equipment that the Instrument Technician works with.

D. Test Instruments and Operating Procedures

Refers to standard test procedures, accuracy requirements, operating principles, sensitivity, error; and the use of electrical, electronic and mechanical test instruments including ammeters, ohmmeters, voltmeters, portable pneumatic test equipment, pressure gauges, manometers, potentiometers, oscilloscopes, temperature baths, dead-weight testers, oscillators, pulse-counters, vacuum tube testers, transistors, heat provers, and portable analyzers. Specifics: pneumatic and electronic instrumentation as applied to process control relays, transmitters, controls, positioners and schematics, includes knowledge of safety procedures as specified by the Edison Accident and Fire Prevention Manual and applicable OSHA regulations, knowledge of electrical and other hazards and precautions.

E. Physics

Includes those principles derived from the science of physics that are essential to an understanding of instrumentation at the steam generating station. Included are the general areas of heat, pressure, hydraulics, mechanical principles and the theory of closed pressure systems and mechanical force balance. Specifics: flow measurement (equations), types of flow measurement devices, temperature and pressure conversions.

Study References

Below is a listing of the study references which can be used in preparation for successful completion of this test. The materials listed in this Guide are available from general company references (e.g. ESM, Accident Prevention Manual, etc.), public/university libraries, general bookstores, university or technical bookstores. Department reference material (e.g., operating letters, on-line computer systems, etc.) are accessible through the Training School of this Division.

GENERAL STUDY:

The Instrument Technician classification is one in which the individual inspects, tests, services, replaces and installs instruments and equipment needed to measure, record, transmit, indicate and control the operation of steam generating station equipment, including electrical, electronic, pneumatic, hydraulic, thermodynamic, and mechanical instrumentation.

COMPANY REFERENCES:

1. Electricity 1A and 2A: S.C.E. Corporate Training and Development
2. Edison Accident and Fire Prevention Manual:

Policy Section: Policy

Section 600: Steam Rules

Section 700: Switching and Clearance Rules

GENERAL REFERENCES:

Technical Publishing Company workbooks which cover the following areas are available from Steam Division Training:

Using Mathematics in the Plant

Introduction to Electricity and Electronics

Batteries and DC Circuits

Transformers and AC Circuits

Foundations of Measurements

Pressure Measurement

Force, Weight and Motion Measurement

Flow Measurement

The following technical books are available in technical bookstores:

Basic Electronics: Grob, Bernard. 5th. Edition. (Ch. 1-6)

Fundamentals of Process Control: Murrill, Paul, Instrument Society of America. (Ch. 2, 3, 5-7)

Instrumentation: Rimbora, Kirk. 3rd. Edition. (Ch. 1, 8, 14 and 15)

Process Control Instrumentation Technology: Johnson, C.D., (Ch. 1, 7, 8, 9 and 11)

Microprocessors and Digital Systems: Hall, Douglas, McGraw Hill Books, (Ch. 2, 3, 6, 8 & 9)

GENERAL STUDY:

The following represents a listing of the material which is recommended for study for this test by Steam Division Training. They should be contacted for the materials.

- 1.0 Pneumatic instrumentation as applied to process control:
 - 1.1 Relays
 - 1.2 Transmitters
 - 1.3 Controls
 - 1.4 Positioners
 - 1.5 Schematics

- 2.0 Electronic instrumentation as applied to process control
 - 2.1 Relays
 - 2.2 Transmitters
 - 2.3 Controls
 - 2.4 Positioners
 - 2.5 Schematics

- 3.0 Control loop logic (pneumatic and electronic) as applied to process control
 - 3.1 Single element
 - 3.2 Three element
 - 3.3 Feed forward
 - 3.4 Cascade
 - 3.5 Closed loop logic
 - 3.6 Proportional control

- 4.0 Microprocessor logic
 - 4.1 ROM
 - 4.2 RAM
 - 4.3 PROM
 - 4.4 Software
 - 4.5 EPROM
 - 4.6 Hardware
 - 4.7 Block diagrams

- 5.0 Principles of Electrical Theory
 - 5.1 Ohm's Law
 - 5.2 Relays
 - 5.3 Diodes
 - 5.4 Circuits and switches
 - 5.5 Elementary diagrams
 - 5.6 Capacitance

- 5.7 Voltage drop
- 5.8 Capacitive reactance
- 5.9 Resistance

6.0 Principles of Physics

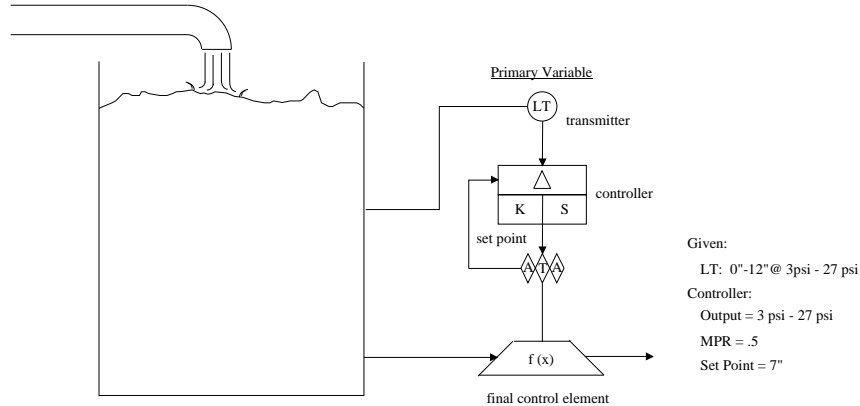
- 6.1 Flow measurement (equations)
- 6.2 Types of flow measurement devices
- 6.3 Temperature conversions
- 6.4 Pressure conversions

Sample Questions

The following are samples of the type of questions, arranged by knowledge area, that you will encounter in this test. An answer page follows the questions.

A. Pneumatic and Control Theory

SINGLE ELEMENT
FIGURE # 1



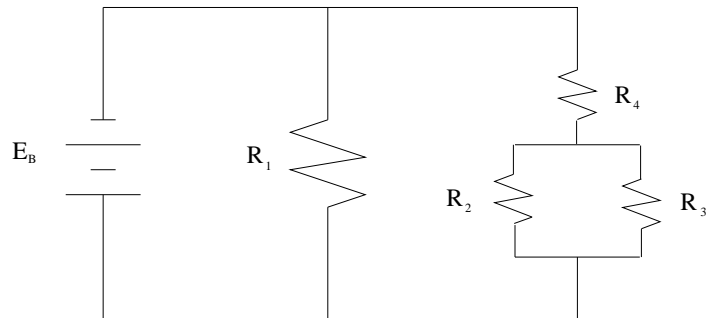
USE THE ABOVE FIGURE FOR QUESTIONS 1 AND 2.

1. What is the proportional band if a step change in the level of 3" causes an output change of the controller to go from 12 psi to 7.2 psi, in the first instant of time?
 - a. .8
 - b. 80%
 - c. 1.25
 - d. 125%

2. If the controller of question #1 output is 15 psi at set point, what will be its output after 1 minute if there is a step change in level to 6"?
 - a. 18.2 psi
 - b. 21.8 psi
 - c. 22.5 psi
 - d. 24.0 psi

B. Electrical and Electronic Theory

FIGURE # 2



In the above figure: $E_B = 12\text{v}$

$R_1 = 60\Omega$, $R_2 = 20\Omega$, $R_3 = 60\Omega$, $R_4 = 45\Omega$

USE THE ABOVE FIGURE FOR QUESTIONS 3 AND 4.

3. What is the voltage drop across R_2 ?

- a. 6v
- b. 5v
- c. 4v
- d. 3v

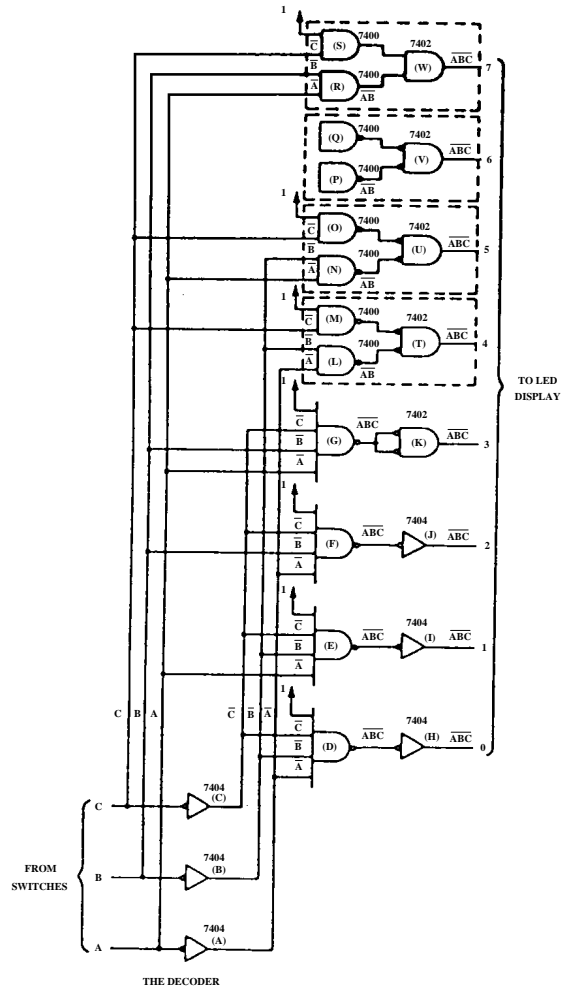
4. What is the current through R_3 ?

- a. 200 ma
- b. 20 ma
- c. 50 ma
- d. .5ma

FIGURE # 3

BCD INPUTS			GATE G INPUTS		
C	B	A	\bar{C}	B	A
0	0	0	1	0	0
0	0	1	1	0	1
0	1	0	1	1	0
0	1	1	1	1	1
1	0	0	1	0	0
1	0	1	1	0	1
1	1	0	1	1	0
1	1	1	1	1	1

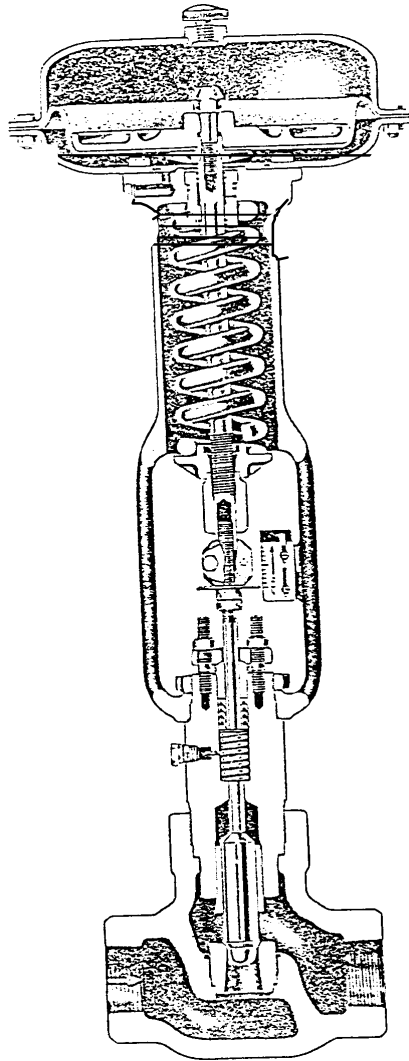
Table



USE THE ABOVE FIGURE FOR QUESTION 5.

5. If the inputs to gate (G) in the decoder circuit above are checked and the results in the Table are as you observed, which circuit component, if any, is most likely defective?
- (A)
 - (B)
 - (C)
 - None

C. Equipment Knowledge



USE THE ABOVE FIGURE FOR QUESTION 6.

- 6. Increasing spring tension will:**
- a. change the stroke of the valve by decreasing it.
 - b. cause the valve to open more quickly.
 - c. increase the length of valve travel.
 - d. cause the valve to start opening at an increased diaphragm pressure.

7. Which of the following is not true of thermocouples?

- a. They do not use a reference junction.
- b. They generate a small voltage.
- c. They are composed of dissimilar metals.
- d. They can be calibrated.

D. Test Instruments and Operating Procedures

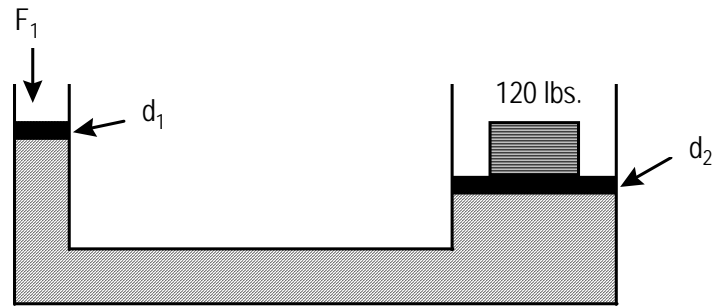
8. To calibrate a pressure transmitter, with a range of 0 psi to 600 psi, to .02% of reading accuracy, which of the following test equipment would be best suited for the calibration?

- a. Precision dial gage.
- b. Precision dead weight tester.
- c. High pressure mercury manometer.
- d. Precision air piston.

9. To troubleshoot a circuit whose input is between 0 to 50 microvolts and output is between 0 to 10 volts, which piece of test equipment is best for the job if the accuracy must be at least 0.001 of a volt?

- a. A DVM with 2 1/2 digit display.
- b. A DMM with 3 1/2 digit display.
- c. A DMM with 20,000 Ω /volt.
- d. Simpson 260 analog meter.

E. Physics



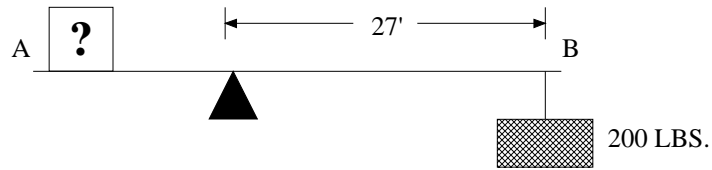
$F_1 = 42 \text{ psi}$ $d_1 = 2 \text{ SQ. FT.}$ $d_2 = 6 \text{ SQ. FT.}$

USE THE ABOVE FIGURE FOR QUESTION 10.

10. In the figure above, the Large piston will be:

- a. moving up.
- b. moving down.
- c. not moving at all.
- d. None of the above.

FIGURE # 5



USE THE ABOVE FIGURE FOR QUESTION 12.

11. In this figure how much weight is needed to balance the beam if the distance from point A to fulcrum is 4 feet less than one third ($1/3$) the distance from point B to the fulcrum?
- a. 2000
 - b. 1080
 - c. 1000
 - d. 580

Answers to Sample Questions

1. b
2. c
3. d
4. c
5. c
6. d
7. a
8. b
9. b
10. a
11. b

Study Guide Feedback

Please use this page to notify us of any changes in policies, procedures, or materials affecting this guide. Once completed, return to:

**Southern California Edison
Performance Assessment Services
GO4 - Ground Floor
8631 Rush St.
Rosemead, CA 91770**

Test Name: **INSTRUMENT TECHNICIAN**

Test No: 2704

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