

PACIFIC GAS AND ELECTRIC COMPANY

PGE + 215 MARKET STREET • SAN FRANCISCO, CALIFORNIA 94106 • (415) 972-7000 • TWX 910-372-6587

January 24, 1989

Local Union No. 1245
International Brotherhood of
Electrical Workers, AFL-CIO
P.O. Box 4790
Walnut Creek, CA 94596

Attention: Mr. Jack McNally, Business Manager

Gentlemen:

The Company proposes, pursuant to Section 109.2 of the Agreement, to revise the Study Guides and Qualification Examination for the classifications of Apprentice Electrical Technician and Substation Electrician as per attached.

- Exhibit I - Apprentice Electrical Technician Examination
- II - Substation Examination
- III - Study Guide for Apprentice Electrical Technician
- IV - Study Guide for Electrician

Specific problems resulting from the administration, correctness or appropriateness of the examinations will be reviewed by the Apprenticeship Committee. Either party may request revision to the examinations.

If you are in accord with the foregoing and attachment and agree thereto, please so indicate in the space provided below and return one executed copy of this letter to the Company.

Very truly yours,

PACIFIC GAS AND ELECTRIC COMPANY

By Richard B. Buegl
Manager of Industrial Relations

The Union is in accord with the foregoing and attachment and it agrees thereto as of the date hereof.

LOCAL UNION NO. 1245, INTERNATIONAL
BROTHERHOOD OF ELECTRICAL WORKERS, AFL-CIO

March 13, 1989

By Jack McNally
Business Manager

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STUDY GUIDE
FOR
APPRENTICE ELECTRICAL TECHNICIAN
QUALIFICATION EXAMINATION

Prerequisites

- * All candidates are required to have passed the Arithmetic Computation Test (ACT).
- * All candidates are expected to be thoroughly familiar with the following:
 - (1) Electrical theory
 - (2) Electronics
 - (3) Substation test equipment
 - (4) Equipment and circuit troubleshooting techniques
 - (5) Electrical drawings
 - (6) Switching procedures
 - (7) Substation Maintenance Practices
 - (8) Substation Bulletins

About the Test

The test consists of 50 questions (100 points) with a three hour time limit. Seventy points is the minimum required to qualify. Test questions emphasize circuit analysis, troubleshooting, use of test equipment, and problem solving.

This test allows you to demonstrate your skills and understanding of electrical equipment as well as your preparedness for advanced technical training with complex relay schemes that are maintained and operated by Electrical Technicians.

Test Administration

All tests are administered by the Power System Maintenance School in San Ramon. A few days after taking the examination, a letter will be forwarded to you through your Human Resources department with the test results. For an unsuccessful attempt the letter will also list suggested areas for further study.

Because of the nature and purpose of this test, review of graded tests as a study or instructional mechanism for preparing to retake the test will not be allowed. Review of graded tests will be limited to the appropriate review committee designated by the Union and Company.

Retaking the Qualifying Test

After the first attempt, you must wait 90 days to retake the test.

After the second attempt, you must wait six months to retake the test.

After the third attempt, you must present satisfactory evidence of additional training to justify a fourth attempt. The evidence could be the successful completion of related courses offered by an institution accredited by the Western Association of Schools and Colleges or through an extension course offered by an accredited institution for an adult education program.

Material Covered in the Test

I. Electrical Theory

- A. Resistive and reactive component operation and construction
- B. Direct and alternating current circuit theory of operation, calculations and analysis
- C. Three phase circuit operation, calculations and analysis
- D. Phasing analysis

II. Electronics

- A. Components
 - 1. Symbol recognition
 - 2. Theory of operation and testing
 - 3. Solder technics
- B. Circuit analysis and application
- C. Logic gates operation and analysis

III. Power Transformers

- A. Theory of operation and calculations
- B. Load tap changer operation and calculations
- C. Bank protection schemes calculations, analysis and theory of operation

IV. Current Transformers

- A. Connections and ratings
- B. Theory of operation and calculations
- C. Performance testing

V. Relays

- A. Time Overcurrent
 - 1. Relay construction
 - 2. Installation and routine tests
 - 3. Relay circuit analysis and troubleshooting
- B. Directional Overcurrent Relays
 - 1. Relay construction
 - 2. Installation and routine tests
 - 3. Relay applications
- C. Tripping and Auxiliary Relays
 - 1. Construction and application
 - 2. Relay tests

VI. Instrumentation

- A. Theory of operation and ratings
- B. Meter analysis and calculations
- C. Transducer operation and calculations

VII. Electrical Drawings

- A. Symbols, devices and wire numbers recognition and function
- B. Single Line Meter and Relay, Elementary and schematic diagrams analysis

VIII. Switching

- A. Switching and tagging procedures
- B. Method for bypassing regulators
- C. Operation of control switches and indicating lights

Sample Test Questions

These sample test questions are included to give you an idea of the kind and types of questions you can expect to find on the qualifying test. These questions do not appear in the actual test, but the nature and difficulty are representative of the ones on the qualifying test. Try completing these questions as a self-test to evaluate your general knowledge and preparedness for qualifying for the Apprentice Electrical Technician Program. (Answers to questions are on the last page of this Study Guide.)

Correct Answers

10 - 8

You should be able to successfully qualify for the program.

7 - 6

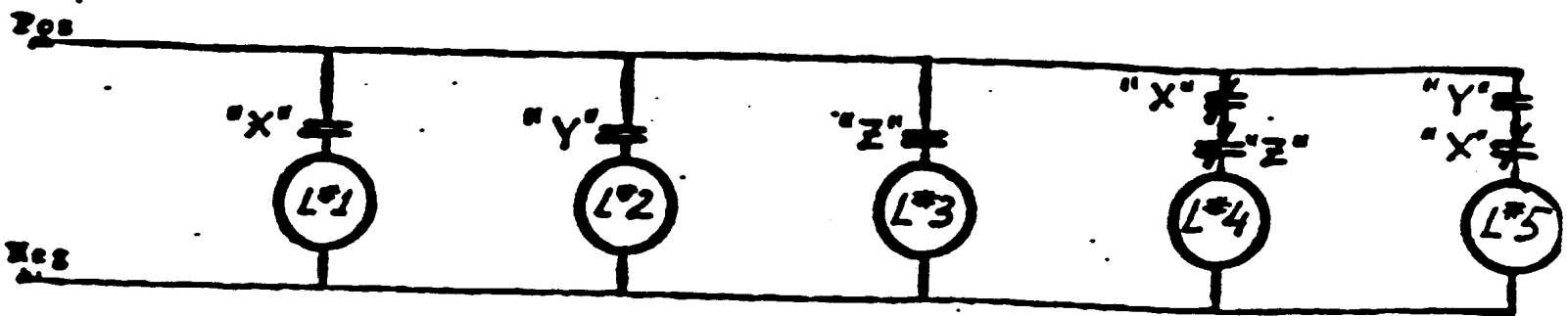
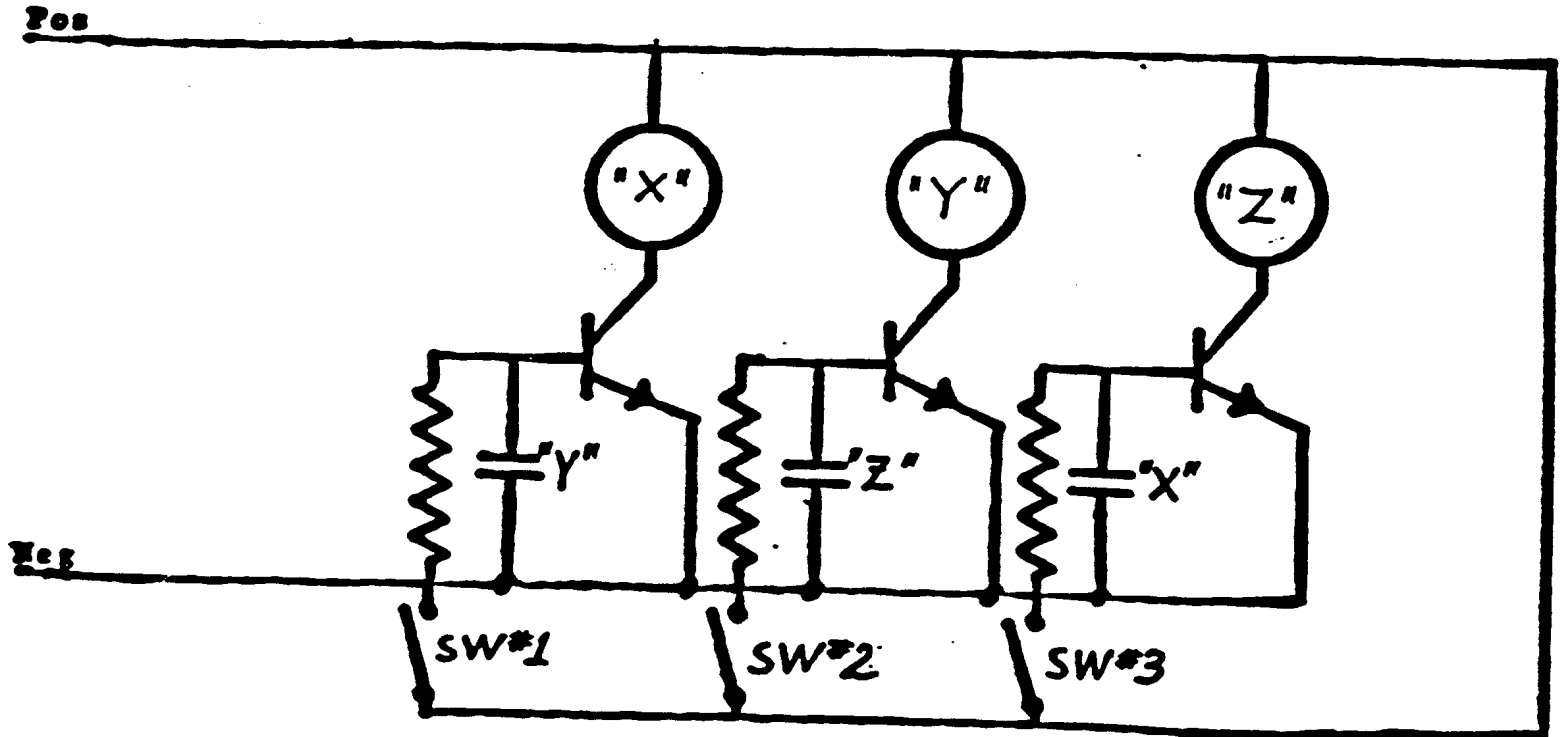
Back to the books.

5 - 0

A long way to go.

(6) Assume all switches open. Switch #1 is closed and then switch #2 is closed. Which lamps are lit?

- A. Lamp #1
- B. Lamps #1 and #2
- C. Lamps #2 and #3
- D. Lamps #1, #3 and #5
- E. Lamps #2, #4 and #5



- (7) A three phase load has a lagging power factor of 86.6%. What is the phase angle between C phase voltage and A phase current?
- A. 5 lags 8 by 330 degrees
 - B. 5 lags 8 by 150 degrees
 - C. 5 lags 8 by 30 degrees
 - D. 5 lags 8 by 270 degrees
 - E. 5 lags 8 by 60 degrees
- (8) The switchboard Wattmeter reads 12 MWatts and the Varmeter indicates 3 Mvars. What is the Power Factor?
- A. 97%
 - B. 25 %
 - C. 82%
 - D. 400%
- (9) This tag is to indicate that a circuit must not be reenergized until first verifying the crew working on the line or equipment are in the clear, following an outage.
- A. Caution tag
 - B. Non Test tag
 - C. Man On Line tag
 - D. Barricades
- (10) The R and X compensator settings are normally associated with:
- A. Overcurrent relays
 - B. Transformer Differential
 - C. Regulators
 - D. Directional relays
 - E. None of the above

SAMPLE QUESTIONS

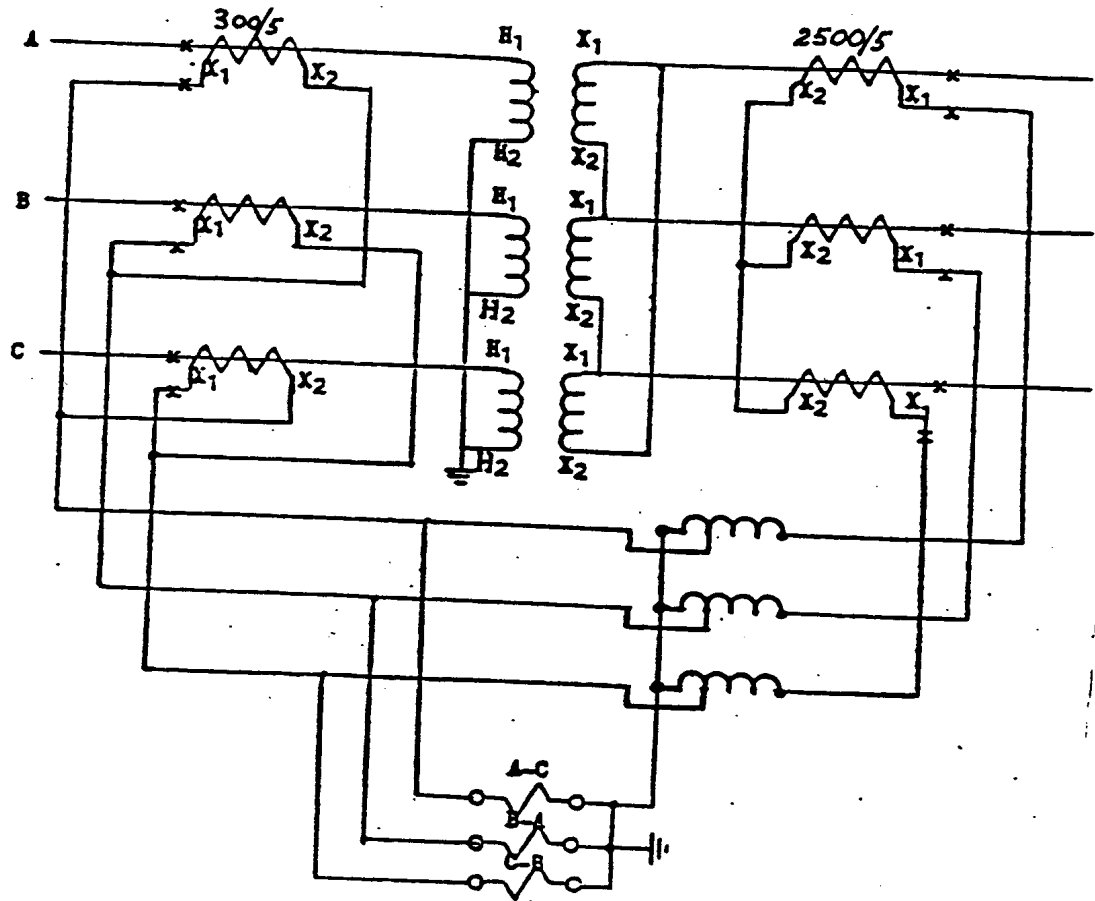
(1) The Transformer below has the following ratings:

3 PHASE OA RATING - 20500 KVA @ 55 C
VOLTAGE RATING - 35500/61500 TO 6900

SETTINGS FOR THE DIFFERENTIAL RELAYS: TAP 3
LEVER 1
INST. 20 AMPS
CBT 190 TURNS

The Percent of Bank Rating for Time Trip is:

- A. 46%
- B. 360%
- C. 94%
- D. 54%
- E. 50%



(2) Performing a Primary Ratio Test on a set of CTs connected A-B Delta with Phase Overcurrent relays in the secondary. Test current is applied to B and C phases. The secondary current read will double in:

- A. C - A RELAY
- B. A - B RELAY
- C. B - C RELAY
- D. GROUND RELAY
- E. NONE OF THE ABOVE

(3) Calculate the Primary Instantaneous to Trip for a Ground relay with settings of Tap 1, Lever 3, Inst. 12 Amps. The Ct ratio is 600/5.

- A. 1800 Amps
- B. 120 Amps
- C. 12 Amps
- D. 1440 Amps
- E. 7200 Amps

(4) Which of the following wiring combinations is correct for a Watt-meter?

- A. 5 - OC and 8 - OP
- B. 7 - 9 and 6 - 4
- C. 9 - OC and 8 - OP
- D. 9 - OC and 6 - 4
- E. 7 - OC and 8 - OP

(5) A logic gate has three inputs. Input X is ON, Y is ON and Z is ON. With the above combination the output is LOW. What gate is it?

CIRCLE ALL THE CORRECT ANSWERS

- A. AND
- B. NAND
- C. OR
- D. NOR
- E. XOR

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STUDY GUIDE
FOR
SUBSTATION ELECTRICIAN
QUALIFICATION EXAMINATION

Prerequisites

All candidates are expected to be thoroughly familiar with the following:

- (1) Electrical theory
- (2) Electronics
- (3) Substation test equipment
- (4) Electrical equipment and circuit troubleshooting techniques
- (5) Electrical drawings
- (6) Switching procedures
- (7) Substation Maintenance Practices
- (8) Substation Bulletins

About the Test

The test consists of 50 questions (100 points) with a three hour time limit. Seventy points is the minimum required to qualify. Test questions emphasize circuit analysis, troubleshooting, use of test equipment, and problem solving.

This test allows you to demonstrate your knowledge and understanding of electrical equipment, testing and maintenance methods as described in the performance requirements for Substation Electricians.

Test Administration

All tests are administered by the Power System Maintenance School in San Ramon. A few days after taking the examination, a letter will be forwarded to you through your Human Resources department with the test results. For an unsuccessful attempt the letter will also list suggested areas for further study.

Because of the nature and purpose of this test, review of graded tests as a study or instructional mechanism for preparing to retake the test will not be allowed. Review of graded tests will be limited to the appropriate review committee designated by the Union and Company.

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Material covered in the test

I. Electrical Theory

- A. Atomic structure, magnetism and static electricity theory
- B. Resistive and reactive component operation and construction
- C. Direct and alternating current circuit theory of operation, calculations and analysis
- D. Three phase circuit operation, calculations and analysis

II. Electronics

- A. Diode and transistor symbol recognition, operation and circuit analysis
- B. Half wave rectifier, full wave rectifier and rectifier filter operation and analysis

III. Electrical Drawings

- A. Symbols, devices and wire numbers recognition and function
- B. Single Line Meter and Relay, Elementary and schematic diagram analysis

IV. Batteries And Battery Chargers

- A. Battery cell connections and maintenance
- B. Battery charging rates
- C. DC Ground Detecting

V. Power Transformers And Regulators

- A. Theory of operation, construction and ratings
- B. Single phase and bank connections and calculations
- C. Maintenance procedures and testing

VI. Current Transformers

- A. Theory of operation, construction and ratings
- B. Three phase connections, calculations and circuit analysis
- C. Maintenance procedures and testing

VII. Instrumentation

- A. Switchboard meters operation, ratings and function
- B. Test Instruments operation, ratings and function

VIII. Relays

- A. Auxiliary relay operation, function and testing
- B. Time and instantaneous overcurrent relay operation, function and testing

IX. Power Circuit Breaker

- A. Theory of operation, construction and function
- B. Maintenance procedures and testing

X. Switching

- A. Switching and tagging procedures
- B. Control, synch and feature switch operation
- C. Phasing analysis

Sample Test Questions

These sample test questions are included to give you an idea of the kind and types of questions you can expect to find on the qualifying test. These questions do not appear in the actual test, but the nature and difficulty are representative of the ones on the qualifying test. Try completing these questions as a self-test to evaluate your general knowledge and preparedness for qualifying for the Substation/Hydro Electrician classification. (Answers to the questions are on the last page of this study guide.)

Correct Answers

- 10 - 8 You should be able to successfully qualify
- 7 - 6 Back to the books
- 5 - 0 A long way to go

Sample Questions

1. A 230 KV. substation's line wattmeter indicates 200 MW. "IN" and the varmeter indicates 124 MVAR. "IN". What is the line current?
 - A. 869 amps; current lagging
 - B. 591 amps; current lagging
 - C. 869 amps; current leading
 - D. 1,023 amps; current leading

2. When a transistor is in saturation the voltage measured from the collector to the emitter is:
 - A. full power supply voltage
 - B. half power supply voltage
 - C. zero power supply voltage
 - D. $V_{CE} = V_{CC} - V_{RL}$

3. Refer to EDS drawing number 461471. Select the best answer for the following conditions: device 143-1 is in the auto position; the line and bus are dead; all FCO's and TCO's are cut in; the breaker is closed and device 43NT is in the test position.
 - A. 152x-1 will operate
 - B. 152-1 will trip by power failure
 - C. 152-1 will trip by device 194B-1
 - D. after the trip the 179-1 motor will run

4. When performing a battery discharge test the individual cell voltage should never drop below 1.75v.

True
False

5. Test pressure on a transformer nitrogen system must be kept below ? PSIG to prevent operation of the pressure relief devices.
 - A. 5
 - B. 7
 - C. 8
 - D. 10

6. When using a station service to supply test current for a secondary ratio you:
 - A. can only perform single phase test ratios
 - B. can perform all necessary test ratios
 - C. lift the ground from the relaying current circuit
 - D. Short all CT's except for the ones under test

7. When scaling switchboard indicating instruments there should be:
 - A. no less than 3 or more than 5 major scale divisions
 - B. no less than 4 or more than 6 major scale divisions
 - C. only 2 submajor divisions
 - D. only 3 submajor divisions

8. It may occasionally happen that an overcurrent relay cannot be adjusted to match its curve at all test values. If this is the case:
 - A. the relay is immediately taken out of service and replaced
 - B. replace the adjusting magnet and retest
 - C. replace the relay pivot jewel and retest
 - D. adjust the relay accurately at 5 times the tap setting

9. Only during emergency situations can a breaker manual closing device be used on energized lines.

True
False

10. Caution tags are used to mark equipment such as switches, valves, gates, machines, etc. Equipment cautioned tagged can only be operated by:
 - A. the station or individual entered on the tag
 - B. a crew member working on the equipment
 - C. an operator or the assigned troubleman
 - D. tagged equipment is never operated until released for service

Answers:

- (1) B
- (2) C
- (3) A
- (4) False
- (5) C
- (6) C
- (7) B
- (8) D
- (9) False
- (10) A

Answers:

- (1) D
- (2) C
- (3) D
- (4) C
- (5) B; D & E
- (6) E
- (7) D
- (8) A
- (9) B
- (10) C