Teaching Methods Employed in a Maintenance Personnel Training Program

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The Port Authority in-plant maintenance training program is described in a general way, with the electrical training program used as an illustration. Emphasis is placed on such factors as the role played by supervisors in curriculum development, the use of well-trained instructors and appropriate training materials, and the proper learning environment.

•THE Port Authority at the present time has a career staff of over 7,000 employees, carrying out its work on a self-supporting basis without cost to the taxpayer. With its vast network of facilities, it has a continuing need for maintenance employees of all skills and abilities.

To provide a well-trained and efficient staff for this exclusive operation, the Port Authority initiated its in-plant maintenance training program over 25 years ago, not only to train personnel, but also to provide employees with the skills necessary to do a better job in their present positions and to obtain promotion to more highly skilled jobs within the organization. Many men have risen to better paying jobs in the Port Authority as a result of the training program. The prime functions of training are to meet the requirements of the employer for skilled people and to provide the employee with a foundation of learning and skill acquirement for his own advancement.

Before discussing our in-plant training, I will attempt to describe one of the programs currently under way, the electrical apprentice training program. This is an all-around program for training maintenance personnel with little experience other than basic schooling to become qualified journeymen electricians. The program is as follows:

PROPOSED PROGRAM ELECTRICAL APPRENTICE TRAINING
Class and Shop Work Sections

	Section Time
Unit I—Basic Mathematics (72 hr)	
Section A—Whole Numbers	9 hr
Section B—Fractions	12 hr
Section C—Decimals	12 hr
Section D—Percentage	9 hr
Section E—Power and Roots	6 hr
Section F—Ratio and Proportion	6 hr
Section G—Simple Formulas	6 hr
Section H—Mensuration	6 hr
Section I—Triangles	6 hr

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	Section Time
Unit II—Basic Science (72 hr)	
Section A—Basic Principles—Science Matter, Measurement	6 hr
Section B—Mechanics and Machines	12 hr
Section C—Magnetism and Electrical Energy	12 hr
Section D—Heat Energy and Heat Machines	12 hr
Section E—Light Energy	6 hr
Section F—Sound Energy	6 hr
Section G—Electronics	12 hr
Section H—Nuclear Energy	6 hr
Unit III—Blueprint Reading and Sketching (72 hr)	
Section A—Preliminary Study of Plans	3 hr
Section B—Unit Substation and High-Voltage Metering Equipment	6 hr
Section C—Feeder Ducts and Distribution Transformers	6 hr
Section D—Panelboards and Sub-Feeders	6 hr
Section E—Lighting Circuits and Systems	6 hr
Section F—Feeder Duct and Plug-In Bus Duct System	6 hr
Section G—Motors and Controllers	6 hr
Section H—Precipitron Units	3 hr
Section I—Synchronous Condensers	6 hr
Section J—Three-Phase Trolley Ducts	3 hr
Section K—Signal Systems	6 hr
Section L—Ventilating, Air Conditioners	3 hr
Section M—Telephone Raceways	3 hr
Section N—Alternate Methods of Feeder Layout	6 hr
Unit IV—Electrical Theory and Circuits (72 hr)	
Section A—Electron Theory and Ohms Law	3 hr
Section B—Series Circuits	3 hr
Section C—Parallel Circuits	3 hr
Section D—Series-Parallel Circuits	3 hr
Section E—Electrical Energy and Power	6 hr
Section F—Batteries	3 hr
Section G—Electrical Conductors and Wire Sizes	3 hr
Section H—Voltage Loss on Conductors	6 hr
Section I—Magnets and Magnetic Fields	6 hr
Section J—Electromagnetism	6 hr
Section K—Generation of Electromotive Force	6 hr
Section L—Direct-Current Motor Principles	6 hr
Section M—Typical Bell Circuits	6 hr
Section N—Switch Control of Lighting Circuits	3 hr
Section O—Wiring Methods and Materials	3 hr
Section P—Remote-Control Systems for Lighting Circuits	6 hr
Unit V—Alternating Current (72 hr)	
Section A—Alternating Current—Principles	6 hr
Section B—Inductance and Inductive Reactance	6 hr
Section C—Capacitance and Capacitive Reactance	6 hr
Section D—Series, Circuit, Resistance, and Inductance	6 hr
Section E—Series, Circuit, Resistance, Inductance, and Capacitance	6 hr
Section F—A-C Parallel Circuits Containing Inductance	6 hr
Section G—A-C Parallel Circuits Containing Inductance, and Capacitance	6 hr
Section H—A-C Power, Power Factor, and Power Factor Connection	6 hr
Section I—Single-Phase Three-Wire Service Entrance	6 hr
Section J—Installation of a Single-Phase Three-Wire Service Entrance	6 hr
Section K—Installation of a Three-Phase Three-Wire Service Entrance	6 hr
Section L—Fluorescent Lighting	6 hr

	Section Time
Unit VI—D-C and A-C Theory—Applied (96 hr)	
D-C Section A—Operation Principles of D-C Generators	3 hr
Section B—The Separately Excited D-C Generator	3 hr
Section C—The Self-Excited Shunt Generator	3 hr
Section D—Compound Wound D-C Generator	3 hr
Section E—D-C Shunt Motor	3 hr
Section F—D-C Series Motor	3 hr
Section G—D-C Compound Motors	3 hr
Section H—Manual Starting Rheostats for D-C Motors	3 hr
Section I—Manual Speed Controllers	3 hr
Section J—Special Starting Rheostats and Controller	3 hr
Section K—Basic Principles of Automatic Motor Control	6 hr
Section L—The Counter-EMF Motor Controller	3 hr
Section M—The Voltage-Drop Acceleration Controller	3 hr
Section N—The Series-Lockout Relay Acceleration Controller	3 hr
Section O—Dynamic Braking With Motor-Reversed Control	3 hr
A-C Section P—Introduction to Polyphase Circuits	6 hr
Section Q—The Three-Phase Wye Connection	6 hr
Section R—The Three-Phase Delta Connection	6 hr
Section S—Basic Principles of Transformers	6 hr
Section T—Single-Phase Transformers	3 hr
Section U—The Single-Phase, Three-Wire Secondary System	6 hr
Section V—Single-Phase Transformers Connected in Delta	3 hr
Section W—Single-Phase Transformers Connected in Wye	3 hr
Section X—Wye and Delta Connections of Single-Phase Transformers	3 hr
Section Y—Instrument Transformers	3 hr
Section Z—Code Requirements for Transformer Installations	3 hr
Unit VII—Advanced Electrical Theory—Circuits and Equipment (51 hr)	
Section A—Physical and Electrical Characteristics of Three-Phase Alternators	3 hr
Section B—Three-Phase Alternator Connections and Windings	3 hr
Section C—Parallel Operation of Three-Phase Alternators	3 hr
Section D—Wiring for Alternating Current Generators	3 hr
Section E—The Three-Phase Squirrel-Cage Induction Motors	3 hr
Section F—Starting Three-Phase Squirrel-Cage Induction Motors	3 hr
Section G—The Starting Compensator	3 hr
Section H—The Three-Phase Wound-Rotor Induction Motor	3 hr
Section I—Manual Speed Controllers for Wound-Rotor Induction Motors	3 hr
Section J—The Synchronous Motor	3 hr
Section K—Controllers for Three-Phase Motors	3 hr
Section L—Three-Phase Motor Installation	3 hr
Section M—Motor Maintenance	3 hr
Section N—Selayn Units	3 hr
Section O—Single-Phase Induction Motors	3 hr
Section P—Repulsion-Type Motor	3 hr
Section Q—A-C Series Motors	3 hr
Unit VIII—Industrial Electronic Controls (72 hr)	
Section A—Electronic Theory	18 hr
Section B—Component Parts, Induction Coils, Tubes, Condenser, Rectifiers, Transformers	12 hr
Section C—Amplifiers	6 hr
Section D—Power Packs	6 hr
Section E—Rectifier Circuits	3 hr
Section F—Push-Pull Circuits	3 hr

	Section Time
Unit VIII—Industrial Electronic Controls (72 hr)-Continued	
Section G—Transistors	3 hr
Section H—Public Address Systems	3 hr
Section I—Boiler Controls	3 hr
Section J—Electrostatic Filters	3 hr

ELECTRICAL TRAINING PROGRAM
Field Work

1. Motor Application and Maintenance
   a. Single-Phase Motors
   b. Three-Phase Motors
   c. D-C Motors
   d. Generators

2. Control Circuits
   a. Boiler Controls
   b. Refrigeration and Air-Conditioning Controls
   c. Runway and Taxiway Controls
   d. Ticket Dispensary—Tolls Equipment
   e. Parcoa Gates
   f. High-Tension Controls
   g. Fire Alarm and Fire Protection Equipment—Proprietary Equipment
   h. Motor Controls and Starters
   i. Emergency Feeders and Generators
   j. Supervisory Controls
   k. Traffic Signal Control
   l. Telephone Systems
   m. CO Analyzers

3. High-Tension
   a. Safety Principles
   b. Mechanism and Transfer Gear
   c. Feeders
   d. Rules and Regulations
   e. Splicing
   f. Runway and Taxiway Circuits
   g. Tools and Meters and Their Use
   h. Operation
   i. Regulators and Transformers

4. Lighting
   a. Cold Cathode
   b. Fluorescent
   c. Mercury Vapor
   d. Incandescent
   e. Germicidal Lamps
   f. Sodium Vapor
   g. Elfaka

5. Electronics
   a. Amplifiers
   b. Power Packs
   c. Rectifier Circuits
   d. Push-Pull Circuits
   e. Transistors
   f. Public Address Systems

   g. Boiler Controls
   h. Electrostatic Filters

6. Special Equipment
   a. 95-foot Hi-Range
   b. 38-foot Bucket Truck
   c. Interior Relamping Rig
   d. Tower Trucks
   e. Other Special Devices

7. Underground Distribution System
   a. Types of Manholes
   b. Manhole Safety
   c. Types of Duct Systems
   d. Manhole Safety Precautions
   e. Manhole Identification
   f. Method of Handling Cable in Underground Systems

8. Overhead Distribution System
   a. Method of Accessibility
   b. Types of Overhead Devices
   c. Safety Rules and Regulations

9. General Distribution System
   a. Circuit-Breakers and Fuses
   b. Types of Distribution Wiring
   c. Types of Wire
   d. Time Current Ratings of Equipment
   e. Relaying Devices (Emphasizing High-Tension)

Normal apprentice training classes consist of 12 to 15 students working as electrical trades helpers. A high school diploma is a requirement; however, an exception may be made for a man who has been an electrical trades helper for five years. These courses generally run from 60 to 180 sessions. Each session usually lasts three hours, and is held once or twice a week at the location where the greatest number of students are concentrated. All of the sessions are given off-shift and the men are not paid for attendance.

This method of in-plant training is highly dependent on an adequate and dedicated staff and the organization of that staff. The instructors are chosen on the basis of their experience, trade skill, proficiency, and teaching ability, plus their background in administration. Our supervisory personnel develop a standard curriculum for each course in their special areas and are responsible for the day-to-day operation of the program. Attendance at an instructor-training seminar is required before one can qualify as an instructor. Many of these instructors have state licenses as qualified teachers.

In addition to electrical apprentice training, training programs include courses ranging from maintenance and clerical skills to supervisory and management development. There is an education refund plan through which employees who successfully complete courses relating to the work of the Authority receive total repayment of tuition fees. Since 1946, several thousand men have risen to better-paying jobs in the Port Authority through our training programs.

The result of adequate in-plant training to the Port Authority has been a more efficient and capable maintenance team. At the same time, in-plant training provides the individual employee with the opportunity to obtain the necessary skills for job advancement and to improve his standard of living. The resulting increased purchasing power is a direct aid to the general economy of the Port of New York communities.

Development of effective training materials, curriculums, and training aids are important to success. We have developed an overall writing guide beginning with our instructor-training course and ranging through all of the skills area. These curriculums are updated frequently and are kept abreast of Port Authority standards and standards of the various trade fields. Standard texts from the fields are used

where necessary. The teaching guide establishes the content of material, and suggests teaching aids, texts, and time allotments for each lesson. Recommended methodology is also included in each teaching guide. A handbook, entitled "Instructors Handbook for the Organization and Administration of an Instruction Program," has been developed within the skills training program and is an established guide to all of our training courses.

The first consideration in any program must be the trainee. The type of student, his age, and his ability must be the concern of the administration and the instructor. Adults are good students when properly motivated and are quite conscious of time invested in learning. They do not appreciate traditional methods of discipline. When their effects are rewarded, however, adults will display pride in their accomplishments. Pride is a reflection of morale and morale is one of the results of training.

Enthusiasm is contagious, expertness is respected, and sincerity is appreciated in the training situation. Successful instructors and supervisors exemplify the traits they want to instill in their students. Instructors themselves should be apt and willing learners. Because they represent the organization, they reflect the caliber of the organization. It is essential, therefore, that they exemplify the best in teaching, organization, management, and administration.

Instructors should see the overall picture of the training program so they can more intelligently understand their part in it. There should be communication between the people concerned with supervising and those instructing. Instructors should use training films, instructional aids, and demonstrations, and there should be application of newly learned skills. Group instruction should be followed by individual instruction when and wherever possible.

Students in maintenance skills training programs should be expected to participate in class discussions, take notes, and perform trade skills. Learning of operational skills should be followed by practical application on the job. If the training session includes a study period, the instructor should help trainees organize study time. He can help individual trainees when they experience difficulties. Some of the most valuable learning experience for trainees will take place in the shop or laboratory. Most valuable of all, of course, is full-time training followed by on-the-job training when possible. Shop and laboratory training are substitutes for on-the-job training. Regardless of site, the importance of shop experience is of extreme value because the trainee will be trying out the new skill in a safe, supervised environment. Programs involving the use of tools, equipment, and material need careful planning. Any shop or practical skills program will present a housekeeping problem and, therefore, a safety problem. Proper housekeeping and safety go hand in hand and are of extreme importance.

Supplementing any training program with an adequate library facility is a necessity. The instructor cannot teach everything, and the trainee cannot learn everything in the confines of a classroom or shop. Reference material should be made available to the trainee, instructor, and administrative staff.

In addition to skills-training, it is prudent to consider the academic advancement of the trainees in two areas—functional English and mathematics. Many employees cannot improve their skills ability because of the lack of formal academic training in these two areas. A carpenter who cannot subdivide a ruler or a plumber who cannot read a blueprint certainly cannot operate effectively in his skills area. In conjunction with skills training, classwork in related English and mathematics should be offered. This may be mandatory in some areas, but in other areas it may simply be considered desirable. Wherever possible, these courses should be under the direct supervision of the in-plant training administration so that the greatest possible benefit can be obtained. Close cooperation must be maintained between the skills-training instructors so that the related courses will be of most benefit to the trainee. This also benefits the trade instructor, who can then concentrate on technical skills training.