

REQUEST FOR QUALIFICATION (RFQ)
FOR
TECHNICAL TRAINING INSTRUCTIONAL DESIGN SERVICES

TRANSIT ELEVATOR/ESCALATOR MAINTENANCE TRAINING CONSORTIUM

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Request for Qualifications

Transit Elevator/Escalator Maintenance Training Project

- A. Introduction and Background Information
- B. Scope of Work Requested
- C. Selection Criteria
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Section A: Introduction and Background Information

The Transportation Learning Center (Center), located in the Washington, DC Metropolitan area, seeks consultants to assist in its work of developing training materials for the transit industry in compliance with National Training Guidelines.

Background Information

Elevators and escalators are important modes of vertical transportation, which rail transit operators are required to integrate into their stations to meet the growing requirements of transit patrons and the legal accessibility requirements of the Americans with Disabilities Act (ADA). EI/Es maintenance is also an important element of risk management and cost management for rail transit organizations. Since 2006, six transit agencies and unions¹ have participated in a Joint Transit Elevator/Escalator (EI/Es) Steering Committee to develop Transit EI/Es Maintenance Training Guidelines. Participants included representatives from six US locations – New York City, Philadelphia, Washington DC, Chicago, Atlanta, and the San Francisco Bay Area. The American Public Transportation Association and the Amalgamated Transit Union were the national sponsors, with the Center serving as staff. The Transit EI/Es Training Consortium commissioned the Center to work with the Consortium's Joint Steering Committee to develop courseware to fully implement the EI/Es National Training Guidelines (see Item F. on page 9 of this document). An analysis of the availability and adequacy of existing EI/Es courseware and analysis was conducted in October 2008 to identify the most cost-effective use of resources in developing instruction-ready occupational training. The recommendation from the Center and the Joint Steering

¹ Vancouver SkyTrain has also participated in this work.

Committee was for a focused cooperative effort among major transit agencies and their unions to develop a comprehensive system of curriculum and courseware. The final product will be a comprehensive transit elevator and escalator training and apprenticeship program.

Section B: Scope of Work Requested

For assistance in this work, the Center requires individuals or organizations with demonstrated instructional design expertise in developing technical training programs. Qualified candidates must have experience working with labor union and management representatives to develop technical training. Trade apprenticeship and/or transportation experience is desirable. The selected candidates will work closely with Center staff in our Maryland office. Qualified candidates will demonstrate how their skill and experience in the following:

Instructional design.

All consultants will need to analyze, design, and develop new courseware to upgrade technical training for transit elevator-escalator technicians and other crafts. Consultants will evaluate existing courseware and identify gaps, design training programs, and write and organize curriculum and courseware. Instructional materials should be designed so that instructors lecture the least often and demonstrate, use small group activities, scenarios and/or role play, as often as possible to actively engage the participants in the learning process. Consultants will work with the Center to implement the training program and assess the results.

E-Learning expertise.

Courseware developed under this project should be designed to utilize current and future trends in eLearning, including but not limited to; synchronous and asynchronous instructor-led e-learning, blended learning, mobile learning, and electronic performance support systems.

Project management.

Working within a joint committee process and with local subject matter experts (SME) requires an ability to communicate effectively with different levels of leadership in both the management and the union. Consultants must manage the instructional design process to obtain timely and effective SME feedback while maintaining an efficient rate of production.

Information technology.

Candidates must be capable of using a variety of software and hardware to communicate with a national network of SMEs and consortium partners. Familiarity with and competence in Word, Excel and PowerPoint is required.

Experience working with labor and management.

Building and sustaining these partnerships requires an ability to understand the needs of both management and labor. Respondents to this RFQ must show a track record of working with labor and management on issues related to training and/or safety.

Technical training courseware development experience.

Transit elevator and escalator maintenance requires a fundamental knowledge of electrical/electronic, mechanical, and hydraulic theory and application. Consultants who can demonstrate their familiarity with developing courseware on these subjects will be better positioned to communicate effectively with SMEs and industry representatives in the instructional design process.

In addition to these needed skills, the Center seeks consultants who can add value in the following:

Transit industry experience.

Elevator and escalator maintenance in a transit environment is significantly different from commercial elevator and escalator maintenance. Consultants who can demonstrate their familiarity with the transit environment will be better positioned to communicate effectively with SMEs and industry representatives in the instructional design process.

Section C: Selection Criteria

The rating process will consist of a three tier system based on the qualifications submitted that are similar to or the same as those specified in the **Scope of Work Requested** section, mentioned above. The rankings are as follows:

- Outstanding
- Satisfactory
- Unsatisfactory

Section D: Submission Requirements

This Request for Qualifications is open on a rolling basis beginning February 28, 2011. Submissions will be accepted continuously. The Center reserves the right to announce a closing of the process at a later date. Such announcement will be made on the Center's website, www.transportcenter.org. Qualifications can be submitted in hardcopy or in electronic medium accessible by PDF or Microsoft Word 2003-2007. Statements of qualifications will be reviewed as business needs of the Center dictate. All potential consultants should provide the following information:

- **Name, place of business, if applicable, and business status of the responding organization**
- **A brief statement of qualifications based on the scope of work requested. This statement should not exceed 2,500 words**
- **Resumes of key project staff**
- **References from three clients with comparable projects**
- **Attachments**
- **A financial proposal estimating how much the work specified here would cost, including an hourly rate and daily rate for your services**
- **Contractors who accept work with the Transportation Learning Center are under the condition that they will not in turn subcontract any of the work without prior, written approval from the Center.**

SUBMISSION OF QUALIFICATION PROPOSAL

The purpose of the proposal is to demonstrate the vendor's qualifications, competence and capacity to undertake services in conformity with the requirements of this solicitation. As such, the substance of the response will carry more weight than the form or manner of presentation. The proposal should demonstrate the qualifications of the vendor and of the particular staff to be assigned to this engagement.

PROPOSALS MUST BE RECEIVED AT THE TRANSPORTATION LEARNING CENTER, 8403 COLESVILLE ROAD, SUITE 825, SILVER SPRING, MD 20910.

**ELECTRONIC COPIES OF THE PROPOSAL CAN BE SUBMITTED TO:
JOYCE.WILLIAMS@TRANSPORTCENTER.ORG**

Section E: Center's Travel Policy & Procedures Manual

The Transportation Learning Center has developed this travel policy with three primary goals in mind:

- To make travel reservations promptly, in order to reduce the cost of travel when possible.
- To ensure that employees know what expenses are allowable and how to be reimbursed for expenses when necessary.
- To allow the Center to file timely invoices with its funding agencies based on prompt submission of travel reports and supporting receipts.

Part 1 – Pre-Travel Approval Process (Center Staff and Contractors)

- All Center staff and contractors traveling more than 15 miles from the Center or the contractor's home (whichever is closer to the destination) must go through a two step process for approval.
- Contractor will email their supervisor within 21 days of travel date requesting travel. The email should include date of departure and return, grants to be billed, and purpose of travel.
- Supervisor will reply to contractor and Travel Coordinator that travel is approved or denied.
- This written documentation will become part of the employee's expense report.

Part 2 – Pre-Travel Coordinating Process

- Center contractors may book their own travel or request the assistance of the Travel Coordinator. If they choose to make their own travel arrangements, contractors must notify the Travel Coordinator of their travel plans when travel is booked. Travel should be booked as early and as cost effectively as possible. If the contractor chooses to have the Travel Coordinator book travel, then the process below must be followed.
- The process for booking travel through the Travel Coordinator is as follows:
 - Travel Coordinator will email proposed travel arrangements to the employee for approval before reservations are booked, as well as confirm dates of conference or meeting attendance (as needed).
 - Employee will email reply back to confirm proposed travel arrangements & Travel
 - Coordinator will finalize booking arrangements.
 - Rebooking travel after acceptance will only be done if an additional trip has been added immediately before or after the original travel dates.

Part 3 – Cancellation/Changes of Accepted Travel Arrangements (Center Staff & Contractors)

- When travel has been approved by the supervisor and travel arrangements have been approved by the traveler, it is the traveler's responsibility to cancel or change all of the arrangements. This includes but is not limited to: airlines, train, rental car, hotel and conference registration. In addition, the Travel Coordinator and the supervisor must be notified by either phone or email of all changes. The Travel Coordinator may assist with changes or cancellations, if requested in advance by the Traveler.
- Unallowable Changes – The cost of changes made due to personal preference with no reasonable savings of time to justify employee cost, or missing transportation due to poor time management skills will be charged to the employee or contractor.
- If the traveler is ill or has an emergency, it is the responsibility of the traveler to cancel or change all hotel/air/train reservations and notify the Travel Coordinator. The Travel Coordinator can assist in cancellations or changes if notification is received either by phone or email prior to the time of travel departure.

Part 4 – Time Recording When Traveling (Center Staff & Contractors)

- Travel time and expenses start when an employee leaves either their home or the Center (depending on where they are located when travel begins). Time spent traveling is to be billed.
- A trip that will be split between two locations and two separate contracts should be split within each day of travel. The travel time to the first location should be billed under contract one. The travel time from location one to location two should be split between the two contracts, and the travel time back from the second location should be billed to the second contract.
- When in the travel location, the day starts when the normal workday starts. If there is a working breakfast, working time starts with breakfast. If there is a working lunch or dinner, time recorded should include that as well. A working meal is considered to be a meal where the employee's presence is mandatory. Breaks to go on non-work related excursions are not to be included in the timesheet for that day. Breaks to contact the Center's office or check e-mail are considered work related.
- If a trip is partially business and pleasure to the same location, the traveling time should be on your timesheet on the actual days of travel. The traveling time is still considered work time.

Part 5 – Approved Travel Expenses Incurred by Employee (Center Staff & Contractors)

- All staff and contractors of the Center are strongly encouraged to secure the most economical means of travel. This will usually involve at least a three-week advance booking for airlines and hotels. In all cases, the booking of travel should be made as early as feasibly possible. Excess costs due to unnecessarily late bookings may be questioned by the Center.
- If an employee books his/her own travel, then the responsibility for filling out the travel form for pre-travel expenses falls to the employee.
- *C. Forms & Receipts (Center Staff & Contractors)*

- It is the employee's responsibility to fill out the Center's expense form that details the expenses. These expense forms must include the following: Employee name, date of travel, time that travel began and ended, reason for the travel, proper billing of travel, amount of the charge, and backup for the charge.
- Reasonable care must be taken that all receipts are accounted for and are enclosed.
- Any receipt under \$50 that is unavailable will be reimbursed if the following is provided: date of charge, reason for charge, amount of charge, vendor. If/when the receipt is located; it should be filed with the appropriate expense reimbursement report. Unavailable receipts over \$50 will be paid at the discretion of the Center's Director.

Part 6 – Travel Expense Reimbursement (Center Staff & Contractors)

- The Center follows the government policies and procedures for travel reimbursement. Both costs and time in travel must be justified as reasonable. The current per diem and mileage schedules are found at their website (www.gsa.gov). The Federal government updates its per diem annually on October 1 and the Center follows these updates.
- Mileage for business travel in your personal auto is calculated on actual miles at the government mileage rate. Meals and incidentals are calculated on the Federal per diem rate in each individual locality.
- If the cost of lodging within a five mile radius of the destination exceeds the government lodging rate, the difference between the actual rate and the government lodging rate is considered an "unallowable" cost. In the event that lodging exceeds the government lodging rate, **supervisor permission must be granted in writing before booking. No unallowable costs will be reimbursed by the Center without advance approval.** This written approval will be included in the expense report documentation.
- A starting point for locating hotel rooms at the government rate is: www.fedrooms.com. Travelers are not limited to a certain website or company when booking travel, particularly if a lower rate can be found at a competitor's website.
- Reasonable tips for skycap, maid and bellman are not part of the per diem for the day. These costs are reimbursable and must be reported under tips, with the type of tip specified in the expense reports.
- Under government contracts, alcoholic beverages are not reimbursable costs. These costs must be treated as "unallowable" costs. Separate bills should be used and paid personally by the employee.
- All expense reports should be turned into the Travel Coordinator.

Section F: National Training Guidelines for Transit Elevator/Escalator Maintenance

Transit Elevator and Escalator Maintenance Training Guidelines Standards

Abstract: This document contains standards for a fully accredited Transit Elevator/Escalator Apprenticeship Program.

Keywords: apprenticeship, elevator, escalator, training

Summary: As of 2007, 25 states have adopted formal elevator and escalator maintenance licensing requirements. The transit agency response correspondingly reflects this regulatory environment, as each agency attempts to develop training specific to their regulating authority. The result is largely an unfunded mandate with which no single transit company can afford to comply. This brief description of the dilemma faced by the industry illustrates the urgent need for national guidelines and related training programs.

Scope and purpose: The curriculum, courseware and training guidelines adopted by the group and contained in this *Recommended Practice* are designed to meet or exceed the licensing requirements of jurisdictions, which currently or in the future, may legislate professional licensure or certification for elevator and escalator technicians. The apprenticeship program will ultimately be registered by the U.S. Department of Labor's Office of Apprenticeship.

1. Development of Standard

The National Elevator/Escalator Maintenance Training Standards Development Committee was formed in 2005 to create a dialog among transit agencies and unions engaged in in-house conveyance equipment maintenance. Several compelling factors brought this group together:

- **First**, the elevator and escalator industry is incorporating digital control technologies into their designs faster than the incumbent workforce can learn these new systems.
- **Second**, every agency has experienced difficulty recruiting qualified elevator/escalator mechanics. In fact, through 2016 the US Department of Labor projects nine percent growth in the number of escalator/elevator positions, leaving transit agencies to compete with private sector employers over an already scarce labor pool. Coincidentally, some 40 percent of the current transit workforce is eligible to retire.
- **Third**, regulatory and legislative changes have required transit agencies to meet state occupational certification requirements for recently hired elevator and escalator maintainers. This regulatory and occupational certification is expected to become more common.

The committee is comprised of labor union and management representatives from North American public transit providers who continue to perform in-house elevator and escalator maintenance. The American Public Transportation Association and the involved transit unions have sponsored this effort, and the Transportation Learning Center (the Center, formerly, the Community Transportation Center) has supported and facilitated this program with funding provided by the U.S. Department of Labor, the Federal Transit Administration and the Transportation Research Board.

1.1 Objective

This committee's ultimate objective is to develop a fully accredited Elevator/Escalator Apprenticeship Program certified through a national joint apprenticeship and training committee and continuing education training programs for incumbent technicians. The curriculum, courseware and training guidelines adopted by the group are designed to meet or exceed the licensing requirements of jurisdictions, which currently or in the future, may legislate professional licensure or certification for elevator and escalator technicians. The apprenticeship program will ultimately be registered by the U.S. Department of Labor's Office of Apprenticeship.

1.2 The committee

1.2.1 Participants

- Agency and unions:
 - BART, SEIU Local 1132
 - CTA, IBEW Local 137
 - MARTA, ATU Local 732
 - MTA, NYCT, TWU Local 100
 - SEPTA, TWU Local 234
 - WMATA, ATU Local 68
- APTA
- Transportation Learning Center

1.2.2 Meeting dates

The National Elevator/Escalator Maintenance Training Standards Development Committee met on the following dates:

- November 28, 2006
- April 3, 2007
- September 14, 2007
- November 7-8, 2007
- February 21, 2008
- June 14, 2008
- September 17, 2008
- November 5, 2008
- January 8-9, 2009

1.3 Current mix of licensing requirements

As of 2007, 25 states have adopted formal elevator and escalator maintenance licensing requirements.

Table 1 describes the current state of elevator and escalator regulation in the jurisdictions represented by the aforementioned transit agencies. This matrix of state and provincial regulations affects transit agencies' authority to service and maintain their equipment.

The agency response correspondingly reflects this regulatory environment as each agency attempts to develop training specific to their regulating authority. The result is largely an unfunded mandate with which no single transit company can afford to comply. This brief description of the dilemma faced by the industry illustrates the urgent need for national guidelines and related training programs.

TABLE 1

Guidelines and Related Training Programs

State/Province	Certification Requirements for Elevator-Escalator Maintainers
California	State-certified apprenticeship with annual renewal. BART is a certified ELES company.
Georgia	Four-year training program and annual recertification.
Illinois	State licensing performed by local constructor unions. Works with two years' experience grandfathered.
Maryland/District of Columbia	State-administered exam and apprenticeship graduate, with grandfathering for experience.
Pennsylvania	State equipment inspections; no contractor licensing requirements.
New York	No state requirement.
Ontario	Provincial certification testing.
Virginia	State-required exam for contractors.

The partnership opportunity created by the transit industry makes developing an elevator/escalator apprenticeship and continuing education program, along with the corresponding courseware, far more manageable for the group than for any single agency.

1.4 Process and tasks

The maintenance training guidelines working group is nearing completion of an interagency apprenticeship and incumbent training curriculum. The next critical steps include a formal courseware sharing agreement between participating agencies and the collection and development of specialized courseware. The immediate critical needs of the agencies involved demands that the process be abbreviated for short-term gains, while continuing with the long term solution of developing a national joint apprenticeship and training program. **Table 2** describes the group's process to date. The adopted apprenticeship curriculum is presented in Section 2.

TABLE 2

Process to Date

Task	Status
1. Job task and maintenance program comparison among participant agencies.	Complete
2. Workforce skills assessment and training evaluation of each agency.	Complete
3. Interagency curriculum and training program comparison.	Complete
4. Comparison of state and provincial training, licensing and certification requirements.	Complete
5. Curriculum development and adoption.	Complete

2. Adopted Elevator/Escalator Apprenticeship Program

The following pages contain the adopted training content for transit elevator and escalator technicians

2.1 100-level courses

Property-specific orientation (including track safety, flagging, emergency evacuation)

101. Orientation and background

- **101-1. General Safety Overview**
 - Name the agencies and organizations that make and enforce safety regulations
 - Name several electrical shock hazards and the techniques used to prevent those hazards
 - Name the four classes of fire and how to extinguish them
 - Describe the technique used to lift a heavy load
 - Explain the importance of personal protective equipment (PPE) and name several types
 - Explain what MSDS stands for and how it applies to them (RtK)
 - Confined space training
- **101-2. Customer Service**
 - Crowd control
 - Operational signage
- **101-3. System Security**
 - Presentation by jurisdiction security force
- **101-4. Station Orientation**
 - Explain how to use the transit system and locate all stations
- **101-5. Safety and emergency procedures**
 - Explain how to reach both internal and external emergency service personnel
- **101-6. Public Safety**
 - Demonstrate the proper barricade setup for both elevators and escalators

102. Electrical and Job Safety

- **102-1. Developing a Safe Attitude**
 - Safety overview, personal responsibility
- **102-2. Using personal protective equipment**
 - Discuss safety rules concerning PPE
 - Determine when and what PPE is required for a job
 - Demonstrate the proper use of various PPE
 - Explain the proper care and storage of PPE
- **102-3. Understanding Electrical Safety**
 - State (by jurisdiction) electrical safety rules
 - Explain basic electrical concepts of current, voltage, resistance and insulation
 - Discuss the hazards of electricity
 - Discuss methods used to prevent electrical accidents
 - Use scientific notation and metric measurements
- **102-4. Lockout/Tagout**
 - Discuss the importance of using correct lockout/tagout procedures
 - Identify various types of lockout and tagout devices
 - Explain how to use lockout/tagout devices
- **102-5. MSDS (right to know)**
 - Recognize the importance of safety and its priority
 - Discuss OSHA laws and their relation to authority
 - Explain how chemicals in the workplace can be a hazard
 - Obtain and use Material Safety Data Sheets

Properly label, store and dispose of hazardous chemicals
Discuss methods used to determine exposure to hazardous substances, and how to minimize harmful effects

103 Tools and Material Handling

• 103-1. Basic Hand Tools

Measuring Tools

- Explain how to hold a rigid rule correctly when measuring an object and show from which point the measurement begins
- Describe how to set lock joint transfer-type calipers
- Identify vernier calipers
- Explain how to take a measurement with a micrometer caliper
- Name the parts of a combination square

Wrenches and Screwdrivers

- Identify types of materials used for making wrenches
- Identify open-end, box-end, socket, socket-head, adjustable, torque and striking-face wrenches
- Describe two sizes that are important in identifying a socket wrench
- Identify standard, Phillips, offset, and spiral-ratchet screwdrivers
- List the steps to follow when driving a screw

Pipefitting Tools

- Identify a straight pipe wrench, a Stillson wrench, a chain pipe wrench, a strap wrench, and a compound-leverage wrench
- Explain how to use a pipe wrench
- Explain why a machinist's vise should not be used for holding pipe
- Explain how to thread pipe
- Explain how to clean a pipe tool
- Explain how to cut and flare tubing
- Explain procedures for brazing
- Demonstrate the ability to braze a section of pipe

Plumbing Tools

- Explain how to use a mechanical tubing bender
- List the steps in joining hubless pipe
- Explain why the drain pipe should be completely covered by the force cup
- Name the criteria used in selecting line-clearing tools
- List the steps in measuring pipe when using the center-to-center measuring systems

Electrician's Tools

- Explain how to use an EMT bender
- Explain and demonstrate the use of an analog and digital meter
- Name the uses of the all-purpose tool
- Demonstrate the use of the all-purpose tool
- Explain the use of a knockout punch

Sheet Metalworking Tools

- Identify the different types of snips and punches
- List six safety practices to follow when working with sheet metal
- Describe different types of sheet metal
- Demonstrate the ability to measure the thicknesses of sheet metal

Metalworking Tools

- Demonstrate the ability to select the proper hacksaw blades for cutting various materials
- Explain the difference between single-cut and double-cut files

- List the types of taps usually found in a tap set
- Explain how to cut an external thread on a bolt, screw, or stud
- Explain how to remove a reamer from a hole

Hoisting and Pulling Tools

- Explain how to prevent synthetic and fiber rope from unraveling
- Explain how individual wires and strands of wire are formed into wire rope
- Identify the most appropriate sling for use near-corrosive chemicals
- Identify a slide-hammer puller
- Describe the different kinds of slings and loads

- **103-2. Basic Power Tools**

Electric Drills

- Name four parts that are common to both the light-duty drill and the heavy-duty drill
- Name the parts of a drill bit
- Explain how to drill a blind hole
- List the safety rules to follow when using electric power tools

Electric Hammers

- Explain the difference in hammering action between a percussion hammer and a rotary hammer
- Select the proper chisel to use for each of the following jobs: brick cleaning; general demolition work; edging, chipping and channeling; and removing floor tile
- List the precautions that should be taken to ensure electrical safety when using an electric hammer
- Name two safety items to use when operating an electric hammer in damp or wet areas

Pneumatic Drills and Hammers

- Explain how drill size is determined
- Describe the chiseling action of a bull point chisel when it is used to clean masonry seams
- Describe how to use a rivet buster
- Explain drill speed requirements
- Identify various types of drill bits used in pneumatic hammers

Screwdrivers, Nutrunners, and Wrenches

- Identify the operating advantages of pneumatic tools
- Define stalling torque
- Describe the clutch action of direct drive, positive drive, and adjustable torque drive
- Explain how to install a bit in an electric screwdriver
- Describe how to install multiple fasteners correctly in a circular pattern
- List safety rules to follow when using power screwdrivers and wrenches
- Describe the difference between pneumatic and electric nutrunners

Linear-Motion Saws

- List other names for both the saber saw and the reciprocating saw
- Describe the cutting action of a saber saw
- Explain how to draw a saw blade with regular set teeth and one with wavy set teeth
- Explain how to plunge cut a rectangular opening
- List the types of band saw blades described in this lesson and a few characteristics of each

Circular Saws

- Name the major parts of a circular saw
- Describe the cutting action of a circular saw
- List the factors that determine feed speed
- State the definition of an arbor
- Identify different types of blades

Electric Sanders

- Explain how to install a sanding belt
- Identify different types of sanding belts
- Explain how to flush the gear chamber of a belt sander
- Discuss the assembly of a sanding disk
- List the safety rules to follow when using a disk sander

Grinders and Shears

- State the meaning of each symbol in the six-symbol standard marking system for grinding wheels
- Explain the correct procedure for mounting a grinding wheel
- List safety rules to follow when using a grinder
- Discuss how to maintain grinders

Tool Sharpening

- State the reasons for sharpening tools
- Explain the use of whetstones
- Identify a bench stone
- Explain how to sharpen taps, dies, screwdrivers, and chisels

- **103-3. Moving Machinery Using a Dolly**

Identify the different types of dollies and their use
Describe the safe procedure of using dollies

- **103-4. Moving Machinery Using Roller Pipes**

Explain the difference between wood and steel pipes
Determine the proper number of rollers required
Explain roller friction

Describe the use of shoes and skids with rollers

- **103-5. Assembly of Gantry Crane**

Describe the proper use of and limits of a gantry crane
Identify the parts of and inspection procedures for each
Properly assemble using correct steps and procedures
Understand the proper use, inspection and assembly of a gantry crane

- **103-6. Rigging and hoisting**

Describe the theoretical principles of the seven basics of mechanisms
Solve basic mechanism problems using concepts of mechanical advantage and friction loss
Identify the types of rigging jobs in which load equalization or load distribution are necessary
Identify the basic rigging safety guidelines
Perform necessary calculations for load equalization and distribution
Describe and classify the various type of wire rope, fiber rope and chains
Properly inspect wire rope and chain
Identify various types of slings and their proper use
Describe the common types of sling hardware and their proper use
Demonstrate how to calculate the efficiency of reeving system

104. Basic Mathematics

NOTE: Committee discussed integrating content of this module throughout other 100-level modules. Content was agreed to in committee, but method for presenting alone or integrating with other modules was not resolved.

- **104-1. Whole Numbers and Arithmetic Operations**

Demonstrate the ability to add, subtract, multiply and divide whole numbers with an accuracy of 75 percent or greater

Identify the place value of digits in a whole number

Identify and list the prime numbers between 0 and 100

Demonstrate the ability to round whole numbers and approximate whole numbers

Demonstrate the ability to solve application (word) problems

- **104-2. Integers and Order of Operations**

Demonstrate the ability to add, subtract, multiply and divide signed numbers and integers with an accuracy of 75 percent or greater

Identify exponential notation

Identify a radical

Demonstrate the ability to work with positive and negative numbers on a calculator

Demonstrate the ability to solve problems observing the order of operations

- **104-3. Decimals and Percents**

Demonstrate the ability to add, subtract, multiply and divide decimals and percentages with an accuracy of 75 percent or greater

Demonstrate the ability to read, order, and round decimals

Demonstrate the ability to multiply and divide by the powers of 10

Demonstrate the ability to convert from percent to decimal and decimal to percent

Demonstrate the ability to calculate percentages

- **104-4. Fractions**

Demonstrate the ability to add, subtract, multiply and divide fractions with an accuracy of 75 percent or greater

Demonstrate the ability to change improper fractions into mixed numbers and mixed numbers into fractions

Demonstrate the ability to reduce a fraction to its lowest terms

Demonstrate the ability to convert fractions to decimals and decimals to fractions

Demonstrate the ability to determine equivalent fractions

- **104-5. Measurements and Applications**

Demonstrate the ability to work with operations of powers of 10

Demonstrate the ability to work with zeros as an exponent, negative exponents and scientific notation

Demonstrate the ability to work with applications of length, weight, area, and volume

Demonstrate the ability to convert between the customary and metric systems

- **104-6. Algebra, Basic Operations**

Demonstrate how to calculate the value of an expression by performing mixed operations in the correct order

Demonstrate how to write an algebraic equation, based on a relationship stated in words

Demonstrate how to solve an algebraic equation for a specific variable

105. Introduction to Electricity

- **105-1. Review Electrical Safety**

- **105-2. Fundamentals of Electricity**

Power supply, distribution and usage

- **105-3. Introduction to Electrical Symbols, Schematics and Print Reading**

- **105-4. Motors Transformers and Switches**

106. Electrical Meters

- **106-1. Multimeter basics**

Explain how meters are used to measure current, voltage, and resistance

- **106-2. Use of meter to measure**

- **106-3. Meter safety**

- **106-4. Understanding meter types**

107. Wiring Technologies and Equipment

- **107-1. Safety Rules in Power Electronics**

Discuss and list the safety rules for avoiding electrical shock

Describe several causes of electrical burns

Know the reason for grounding of electrical equipment

Determine dangerous levels of electrical current as it relates to the human body

- Physiological effects of electric current on the human body
- Rules for safe practice and avoiding electric shock
- Avoiding burns and avoiding equipment related injuries

- **107-2. Wiring Tools and Insulation Removal**

Discuss and identify by name the different types of hand tools associated with wire

Demonstrate the ability to strip various types of insulation materials from different gauges of wire

- Hand tools
- Stripping techniques
- Demonstration and practice

- **107-3. Hand Splicing Techniques**

Demonstrate the ability to make each of the splice types discussed and demonstrated

- Western Union
- Twisted pair
- Fixture joint
- Knotted tap

- **107-4. Mechanical Terminals**

Know the maximum allowable temperature for heat shrink tubing

Demonstrate the ability to make several wire splice connections utilizing wirenuts

Demonstrate the ability to install heat shrink tubing on various wire connections

- Wire nuts and bolt splices
- Snap-lock splices
- Splice insulation

- **107-5. Electrical Wiring, Connector and Terminal Repair**

Discuss the advantage of crimped terminal repairs vs. soldering

Demonstrate the ability to install various sizes of crimp-on wiring terminals both insulated and non-insulated

Explain the difference in terminals and splices used on aluminum wiring as compared to other wiring materials

Discuss why pre-insulated terminals and lugs are color-coded

- Non-insulated terminals and splices
- Specialized terminals for aluminum wire
- Preinsulated terminals lugs and splices
- Specialized crimping techniques

- **107-6. Solder and Soldering Process**

Discuss the advantages of using soldering to join two pieces of metal together as an electrical path

Discuss the nature of solder and the wetting action

Explain the proper technique for applying solder and handling the soldering iron during the solder process

Demonstrate the ability to correctly tin various sizes of stranded wire

Identify the correct tolerances allowed for insulation clearance when soldering to different types of terminals

Explain the various wrapping techniques

Review and discuss the steps of the soldering process

Explain why flux is used in the soldering process

Demonstrate the ability to properly wrap and solder various types of electrical terminations
Identify the characteristics of both acceptable and unacceptable solder connections

108. DC Fundamentals

- **108-1. Safety Rules in Power Electronics**

Discuss and list the safety rules for avoiding electrical shock

Describe several causes of electrical burns

Know the reason for grounding of electrical equipment

Determine dangerous levels of electrical current as it relates to the human body

- Physiological effects of electric current on the human body
- Rules for safe practice and avoiding electric shock
- Avoiding burns and avoiding equipment related injuries

- **108-2. Science of Electricity and Electronics**

Identify the relationship between elements and compounds

Diagram a model of an atom

Discuss the concepts of atomic weight and atomic number

State the law of charges and explain it using examples

Explain what is meant by electric current, voltage and resistance

Describe the two theories of current direction

Distinguish between conductors, insulators and semiconductors

State and explain Ohm's law

- **108-3. Basic Instruments and Measurements**

Explain and demonstrate the correct procedure for using an ammeter, a voltmeter, and an ohmmeter

Discuss the difference between a DMM and a VOM

Interpret a linear scale

Interpret a nonlinear scale

Calculate the values of shunt resistors and multiplier

Discuss the concept of meter sensitivity

Understand basic electrical diagrams

- **108-4. Circuit Materials, Energy and Source of Electricity**

Identify different conductor and insulator materials

Discuss the factors that affect resistance in a conductor

Identify different types of switching devices

Identify different types of resistors

Determine the value of color coded resistors

Calculate electrical power in watts

Convert horsepower to watts

Define polarization as it relates to an electrical circuit

Determine efficiency of an electrical circuit

Combine Ohm's law and Watt's law to find unknown values in a given circuit

Discuss different sources of electrical energy

Explain the difference between primary and secondary

Calculate the outputs of batteries connected in series and parallel

- **108-5. Series Circuits**

Determine the total resistance of a series circuit

Determine the voltage drops in a series circuit

Determine the current values of a series circuit

Determine the wattage values of a series circuit

Apply Ohm's law to solve for unknown voltage, current, and resistance in a series circuit

Apply series circuit theory to assist in troubleshooting a series circuit

- **108-6. Parallel Circuits**
 Determine the total resistance of a parallel circuit
 Determine the voltage drops in a parallel circuit
 Determine the current values of a parallel circuit
 Determine the wattage values of a parallel circuit
 Apply Ohm's law to solve for unknown voltage, current, and resistance in a parallel circuit
 Apply parallel circuit theory to assist in troubleshooting a series circuit
- **108-7. Combination (Series-Parallel) Circuits**
 Determine the equivalent circuit resistance for a given combination circuit
 Determine the voltage drops in a combination circuit
 Determine the current values of a combination circuit
 Determine the wattage values of a combination circuit
 Apply combination circuit theory to troubleshoot a combination circuit

109. AC Fundamentals

- **109-1. Alternating Current Principles**
 Explain how a generator is used to produce alternating current using a graph to show a typical AC wave
 Define and calculate average (avg), effective (rms), instantaneous voltage (vinst) and voltage peak to peak (vpp)
 Demonstrate the ability to operate an oscilloscope while performing typical circuit measurements (amplitude, frequency, time, phase, etc.)
 Determine voltage both AC and DC using an oscilloscope
 Determine the frequency of a waveform using an oscilloscope
- **109-2. Transformers**
 Explain and demonstrate important operating characteristics of single-phase transformers
 Connect transformer windings in series-aiding or series-opposing configurations
 Calculate the current and voltage ratios for a given transformer
 Determine the phase relationship of a transformer primary to secondary
 Determine the frequency of a waveform using an oscilloscope
- **109-3. Series Circuits**
- **109-4. Parallel Circuits**
- **109-5. Combination (Series-Parallel) Circuits**
- **109-6. Basic troubleshooting theory (AC-DC)**

110. Basic Hydraulic and Pneumatic Theory & Applications

- **110-1. Safety Rules in Power Hydraulics and Pneumatics**
- **110-2. Basic Hydraulic Principles**
 Hydraulic pumps, valves, actuators
- **110-3. Basic Pneumatic Principles**
 Pneumatic Pumps – Valves – Actuators
- **110-4. Basic Hydraulic and Pneumatic Symbols, Schematics and Print Reading**

111. Basic Mechanical Theory & Application

- **111-1. Mechanical Power Transmission**
 Discuss the different styles of belts that are used in industry
 Discuss the benefits of a positive-drive belt
 Discuss the benefits of a chain drive system
 Discuss the use of gears and gearboxes
 Define pitch diameter, circular pitch, pitch line and gear ratio
 Perform speed calculations for belt drives, gear drives, and chain drives

- Assemble and perform alignments on belt drives, gear drives, and chain drives
- Properly tension belts and chains
- **111-2. Pumps and Compressors**
 - List types of pumps in use today
 - Explain and calculate volumetric efficiency
 - Explain and calculate the delivery of a pump
 - Discuss some of the common problems that may be encountered while troubleshooting a pump
- **111-3. Fluid Power**
 - Discuss some fluid power fundamentals
 - Explain psi, psig, psia, and inches of mercury ("Hg)
 - Understand how force is transmitted through a hydraulic system
 - Understand the effects of compressing air for a fluid power system
 - Learn how to recognize the different valves that may be used in an fluid power system
 - List and explain at least eight methods of valve actuation
 - Discuss the operation of different actuators
 - Use a hydraulics/pneumatics trainer to construct fluid systems for various operations
- **111-4. Lubrication**
 - Explain some basic terms that are used when referring to lubrication
 - Discuss the necessity for lubrication
 - Discuss the different forms of lubrication
 - List the types of lubricants used in industry
 - Discuss application of lubrication
 - Discuss the importance of a lubrication schedule
 - Demonstrate the proper use of a viscometer
 - Lubricate equipment using a grease gun and chain oiler
- **111-5. Bearings**
 - Define radial, axial, and radial-axial loads
 - List the different parts of a bearing
 - List the different types of antifriction bearings and the different types of plain bearings
 - Correctly install and remove a bearing
 - List several reasons for bearing failure
- **111-6. Coupled Shaft Alignment**
 - Discuss the fundamentals of shaft coupling alignment
 - Demonstrate how to correctly use the dial indicator to align coupling shafts
 - Demonstrate the use of the reverse dial indicator method to correct coupling shaft misalignments
 - Demonstrate how to use the feeler gauge, taper gauge and dial caliper to detect and correct coupling shaft
 - Explain the advantages and disadvantages of using a laser alignment kit to detect and correct coupling shaft misalignments
- **111-7. Seals and Packing**
 - Discuss the different styles of belts that are used in industry
 - Discuss the benefits of a positive-drive belt
 - Discuss the benefits of a chain drive system
 - Discuss the use of gears and gearboxes
 - Define pitch diameter, circular pitch, pitch line and gear ratio
 - List different types of gears
 - Perform speed calculations for belt drives, gear drives and chain drives
 - Assemble and perform alignments on belt drives, gear drives and chain drives
 - Properly tension belts and chains

2.2 200-level courses

200. Overview of vertical transportation

- **200-1. Elevator/Escalator Types and Styles**
- **200-2. Elevator/Escalator Components and Controls**
- **200-3. Simulator Orientation**
- **200-4. Hydraulic and Pneumatic Diagrams**
- **200-5. Elevator and Escalator as-built drawing review**

201. AC Motors, DC Motors and Generators

- **201-1. Magnetism**
Explain the basic magnetic principles
State the three laws of magnetism
Describe the link between electric current and magnetism
Explain Roland's law
Discuss various types of relays and the manner in which they work
Describe the use of magnetic shields
- **201-2. Fundamentals of Rotating Machines**
- **201-3. DC Motors and Generators**
Explain the operating principles of a DC motor
Explain counter-electromotive force
Identify various DC motors
Discuss the purpose for, and operation of, motor starting circuits
Identify and explain the operation of various DC motors
State the function of the field windings in a DC generator or motor
State the function of the armature in a DC generator or motor
- **201-4. AC Motors**
Discuss the operation of an induction motor
Identify and explain the operation of various three-phase motors
Explain how a split-phase condition is created
Discuss the purpose of AC motor protection circuits
List the common causes of motor failure
Explain basic trouble shooting techniques for AC motors
- **201-5. Motor Controls**
- **201-6. AC Induction Motors**
Describe the operation of an induction motor
- **201-7. Synchronous Motors**
Describe the operation of a synchronous motor
- **201-8. Three Phase Synchronous Operation**

202. Troubleshooting Electrical/Electronic Systems

- **202-1. Symbols and Circuits Review**
- **202-2. Meters and Terminology Review**
- **202-3. Introduction to troubleshooting DC and AC systems**
- **202-4. Introduction to troubleshooting digital systems**
- **202-5. Circuits Measurement**

203. Introduction to Electrical Ladder Drawings

- **203-1. Ladder Logic vs. Ladder Diagrams**
- **203-2. Reading and interpreting schematics and circuits**

- **203-3. Understanding International diagrams and symbols**
- **203-4. Interpreting blueprints and flow charts**
- **203-5. Concepts of relay logic**
- **203-6. Understanding terminology**
- **203-7. Interpreting logic gates and diagrams**

204. AC Circuit Analysis

- **204-1. Inductance and RL Circuits**
 Define the terms inductor and inductance
 Explain how inductance affects current
 Calculate the transient response time for an RL circuit
 Define mutual inductance
 Use various measuring and computing methods to determine the values of currents and voltages in an inductive circuit
 Determine inductive reactance by using measurements of circuit currents and voltages
 Calculate the equivalent inductance in both series and parallel circuit arrangements
- **204-2. Capacitance and RC Circuits**
 Define the terms “capacitor” and “capacitance”
 Explain how capacitance affects current
 Calculate the transient response time for an RC circuit
 Use various measuring and computing methods to determine the values of currents and voltages in a capacitive circuit
 Determine capacitive reactance by using measurements of circuit currents and voltages
 Calculate the equivalent capacitance in both series and parallel circuit arrangements
- **204-3. Tuned Circuits and RLC Networks**
 Explain resonant frequency and how it affects various RCL circuits
 Calculate a resonant frequency
 Discuss the characteristics of a series RCL circuit at its resonant frequency
 Discuss the characteristics of a parallel RCL circuit at its resonant frequency
 List four types of filters and explain their action

205. Semiconductor Fundamentals

- **205-1. Safety Review**
 Discuss and list the safety rules for avoiding electrical shock
 Describe several causes of electrical burns
 Know the reason for grounding of electrical equipment
 Determine dangerous levels of electrical current as it relates to the human body
 - Physiological effects of electric current on the human body
 - Rules for safe practice and avoiding electric shock
 - Avoiding burns and avoiding equipment related injuries
- **205-2. Semiconductors, diodes**
 Explain and demonstrate important operating characteristics of single-phase transformers
 Connect transformer windings in series-aiding or series-opposing configurations
 Calculate the current and voltage ratios for a given transformer
 Determine the phase relationship of a transformer primary to secondary
 Determine the frequency of a waveform using an oscilloscope
- **205-3. DC Power Supplies – Single Phase**
 Draw and describe the basic operation of a half-wave rectifier circuit
 Draw and describe the basic operation of a full-wave rectifier circuit
 Draw and describe the basic operation of a full-wave bridge rectifier circuit
 Describe the basic action of a filter using a simple schematic diagram

Explain the methods used for improving filtering action

Construct and test a simple DC power supply circuit

- **205-4. Solid-State Transducers**

Describe the purpose of a transducer

List various types of transducers

Describe the operation of a PTC and NTC thermistor

Identify typical applications of common transducers

Describe the operation of a Hall effect transducer

- **205-5. Transistor theory**

Identify PNP and NPN transistor symbols and their respective component leads

Explain the operation of a bipolar transistor

Identify key factors on a transistor operation curve

Identify common base, common collector and common emitter circuit configurations

Explain the methods used for testing a bipolar transistor

Demonstrate the ability to properly test a bipolar transistor

Silicon-controlled rectifiers (SCRs)

- Identify and label the schematic diagram of an SCR
- Explain the operation of an SCR
- Describe how an SCR operates using a simple circuit
- Describe how an SCR can be used as a switch to control a simple lamp circuit
- Describe how an SCR can be used to vary the current in a simple lamp circuit
- Demonstrate the ability to properly test and SCR

Triacs, diacs and unijunction transistors

- Draw the schematic symbol and describe the basic operation of a triac
- Draw the schematic symbol and describe the basic operation of a diac
- Draw the schematic symbol and describe the basic operation of a UJT
- Describe the typical applications of a triac
- Describe the typical applications of a diac
- Describe the typical applications of a UJT

The transistor as an amplifier

- Describe amplifier concepts using a typical circuit for illustration
- Describe the three main classes of amplification using typical circuits

206. Digital Fundamentals

- **206-1. Digital Technology**

Describe the characteristics of industrial and electronic revolutions

List the members of the technical team in electronics and describe their typical educational backgrounds

Define such terms as “analog,” “signal,” “digital signal,” “bus,” “MSB,” “LSB,” “DIP,” “IC,” “TTL,” and “CMOS”

Count to at least 20 in the binary system and convert binary numbers to decimal

List names given to the two logic levels

- **206-2. Logic Elements**

Recognize switch-based AND, OR and NOT circuits and explain their actions in terms of truth tables and Boolean algebra expressions

Recognize symbols for integrated circuit AND, OR and NOT logic elements and explain their actions in terms of truth tables, Boolean expressions and timing diagrams

Describe the actions of multi-input logic elements

Predict logic levels at all points in circuits containing AND, OR and NOT elements

- **206-3. Combination Logic**

Construct truth tables for combinational logic circuits containing AND, OR and NOT elements based on their logic diagrams

Construct truth tables for such circuits based on their Boolean expressions

Write Boolean expressions for combinational logic circuits composed of AND, OR and NOT elements based on their logic diagrams

Draw logic diagrams for such circuits based on their Boolean expressions

Write Boolean expressions for combinational logic circuits composed of AND, OR and NOT elements based on their truth tables using sum-of-products and product-of-sums methods

- **206-4. NAND, NOR, XOR Elements**

Construct truth tables for combinational logic circuits containing AND, OR and NOT elements based on their logic diagrams

Construct truth tables for such circuits based on their Boolean expressions

Write Boolean expressions for combinational logic circuits composed of AND, OR and NOT elements based on their logic diagrams

Draw logic diagrams for such circuits based on their Boolean expressions

Write Boolean expressions for combinational logic circuits composed of AND, OR and NOT elements based on their truth tables using sum-of-products and product-of-sums methods

- **206-5. Binary Number Shortcuts**

Count using the binary numbering system

Compare place values for the digits of binary numbers

Convert binary numbers to decimal and decimal numbers to binary

Add unsigned binary numbers

Determine the two's complement of binary numbers and use the two's complement method to do binary subtraction

Add signed binary numbers

Determine if overflows have occurred when binary numbers have been added

- **206-6. Numbering Systems and Codes**

Count using the octal and hexadecimal numbering systems

Convert between binary and octal numbers and between binary and hexadecimal numbers

Convert between decimal and octal numbers and between decimal and hexadecimal numbers

Convert between decimal and binary-coded decimal numbers

Describe the nature of the gray code and its most important application

State the meaning of the term "ASCII"

207. Hydraulic and Pneumatic Applications

- **207-1. Practical Hydraulics**
- **207-2. Practical Pneumatics**
- **207-3. Hydraulic and Pneumatic drawings (review, troubleshooting applications)**
- **207-4. Applications of Hydraulics and Pneumatics for ELES**
- **207-5. Hydraulic and Pneumatic logical troubleshooting**

208. Escalator-Specific: Principles of Operation

- **208-1. Safety Procedures**
- **208-2. Principles of Escalator Operation**
- **208-3. Escalator Structural Overview**
- **208-4. Main Drive Systems**
- **208-5. Handrail Drive Systems**
- **208-6. Braking Systems**
- **208-7. Control Systems**

209. Escalator-Specific: Electrical Systems

- **209-1. Safety Procedures**
- **209-2. Electrical Systems Sequence of operation**
- **209-3. Power Supplies**
- **209-4. Wiring Supplies (NEC Code Compliance)**
- **209-5. Safety Circuits**
- **209-6. Control Circuits**
- **209-7. Drive Motor Inspection and Maintenance**
- **209-8. Troubleshooting escalator electrical**

210. Escalator-Specific: Step Installation and Maintenance

- **210-1. Safety Procedures**
- **210-2. Inspection and Troubleshooting**
- **210-3. Step Removal and Replacement**
- **210-4. Roller Removal and Replacement**
- **210-5. Rack Maintenance**
- **210-6. Alignment and Adjustment**

211. Escalator-Specific: Handrail Installation & Maintenance

- **211-1. General Safety Procedures**
- **211-2. Handrail Drive Systems**
- **211-3. Inspection and Troubleshooting**
- **211-4. Handrail Removal and Replacement**

212. Escalator-Specific: Inspection and Basic Maintenance

- **212-1. Lighting**
- **212-2. Steps**
- **212-3. Handrails**
- **212-4. Safety devices**
- **212-5. Drive systems**
- **212-6. Brakes**
- **212-7. Controllers**
- **212-8. General Housekeeping procedures**
- **212-9. Operational Test**
- **212-10. Code Compliance Overview / Jurisdictional testing**
- **212-11. Internal communications (authority specific learning objectives)**

Glossary of local terms and language

Reporting requirements and forms

Communication procedures

213. Elevator-Specific: Principles of Operation

- **213-1. Safety Procedures**
Entrapment response, evacuation
- **213-2. Traction (Electrical) Elevators & MRL Elevators**
- **213-3. Hydraulic Elevators**
- **213-4. Rack & Pinion Elevators**
- **213-5. ADA Accessibility (Wheelchair Lifts)**
- **213-6. Door Systems**
- **213-7. Control Systems**
Understand relay logic
Understand programmable logic
- **213-8. Authority Specific Entrapment Guidelines**

- **213-9. Introduction to Code Specifications (ASME 17.1A)**

214. Elevator-Specific: Electrical Systems

- **214-1. Safety Procedures**
- **214-2. Electrical Systems sequence of operations**
- **214-3. Power Supplies**
- **214-4. Wiring Systems (NEC Code Compliance)**
- **214-5. Safety Circuits**
- **214-6. Control Circuits**

215. Elevator-Specific: Drive System Maintenance & Repair

- **215-1. General Safety Procedures**
- **215-2. Troubleshooting**
- **215-3. Gear Drive Systems**
- **215-4. Gearless Drive Systems**
- **215-5. Hydraulic Drive Systems**
- **215-6. Component Removal and Replacement**
- **215-7. Lubrication Requirements and Adjustments**

216. Elevator-Specific: Principles of Door Operation & Maintenance

- **216-1. Safety Procedures**
- **216-2. Principles of Elevator Door Operation**
- **216-3. Troubleshooting**
- **216-4. Lubrication and Adjustments**
- **216-5. Component Removal and Replacement**
- **216-6. Alignment and Testing**
- **216-7. Code Compliance**

217. Elevator-Specific: Traction (Electric) Elevators/MRL

- **217-1. Safety Procedures**
- **217-2. Drive Systems**
- **217-3. General traction and MRL systems**
- **217-4. Control Systems**
Selector
- **217-5. Roping**
Maintaining Sheaves
- **217-6. Hoistway**
- **217-7. Troubleshooting**
- **217-8. Maintenance Requirements**
Lubrication
- **217-9. Code Compliance**

218. Elevator-Specific: Hydraulic Elevators

- **218-1. Safety Procedures**
- **218-2. Drive Systems**
- **218-3. Control Systems**
Selector
- **218-4. Hoistway**
- **218-5. Troubleshooting**
- **218-6. Maintenance Requirements**
Lubrication

- **218-7. Code Compliance**

219. Elevator-Specific: Inspection and Basic Maintenance

- **219-1. Elevator Car**
- **219-2. Lighting**
- **219-3. Safety Devices**
- **219-4. Machine room & Drive Systems**
Valve system
Piston seals and jack
Oil
- **219-5. Brakes**
- **219-6. Controllers**
- **219-7. Hoistway**
- **219-8. Hall / Landing devices**
- **219-9. General Housekeeping procedures**
- **219-10. Emergency Equipment**
- **219-11. Code compliance review**

220: Elevator-Specific: Other Systems

- **220-1. Rack & Pinion Elevators**
Safety Procedures
Drive Systems
Control Systems
Hoistway
Troubleshooting
Maintenance Requirements
Code Compliance
- **220-2. Dumbwaiters**
Safety Procedures
Drive Systems
Control Systems
Hoistway
Troubleshooting
Maintenance Requirements
Code Compliance
- **220-3. Wheelchair lifts**
Safety Procedures
Drive Systems
Control Systems
Hoistway
Troubleshooting
Maintenance Requirements
Code Compliance

2.3 300-level courses

300. Electrical/Electronic Systems

- **300-1. Electric Motor Drives**
- **300-2. Mechanical and Solid State Switches**
- **300-3. Testing Diodes, Transistors and Thyristors**
- **300-4. Troubleshooting electronic systems**

301. Advanced Electrical Ladder Drawings

- **301-1. Multiple Page Prints**
- **301-2. Electronic Sensors**
- **301-3. International Drawings**
- **301-4. PLC Prints**
- **301-5. Troubleshooting Exercises**

302. Automated Equipment

- **302-1. Understanding Control Devices**
- **302-2. Sensors – Primary Purposes**
- **302-3. Digital control Devices**
- **302-4. Variable Control Devices**
- **302-5. Applications**
- **302-6. Troubleshooting Exercises**

303. Elevator-Specific Courses by Manufacturer and/or Model

- **303-1. Elevator-Specific: Principles of Operation**
- **303-2. Elevator-Specific: Electrical/Control Systems**
- **303-3. Elevator-Specific: Troubleshooting**
- **303-4. Elevator-Specific: Drive System Maintenance & Repair**
- **303-5. Elevator-Specific: Principles of Door Operation & Maintenance**
- **303-6. Elevator-Specific: Inspection and Maintenance**
- **303-7. Elevator-Specific: Safety Devices**

304. Escalator Specific Courses by Manufacturer and/or Model (e.g., Kone, Fujitec, Schindler, Otis)

- **304-1. Escalator Specific - Principles of Operation**
- **304-2. Escalator Specific - Electrical / Control Systems**
- **304-3. Escalator Specific - Troubleshooting**
- **304-4. Escalator Specific - Drive System Maintenance & Repair**
- **304-5. Escalator Specific - Step Installation & Maintenance**
- **304-6. Escalator Specific - Handrail Installation & Maintenance**
- **304-7. Escalator Specific - Inspection and Maintenance**
- **304-8. Escalator Specific - Safety Devices**

2.4 400-level courses

400. Advanced Controllers

- **400-1. Controller functions and Components**
- **400-2. Relay Logic**
Interpretation of Relay-type Instructions
- **400-3. Solid state controllers**
- **400-4. Programmable Controller Systems**
- **400-5. Troubleshooting I/O Devices and Processors**
Controller Diagnostics
Diagnostic use of laptop or handheld device
- **400-6. Controller Programming / Reprogramming / Upgrading**
Programming Terminology

401. Manufacturer-Specific Controllers

- **401-1. SLC500 Processor Operation**

- **401-2. Introduction to RSLogic Software**

402. Advanced Equipment Inspections

- **402-1. Use of human senses to identify problems**

403. Root Cause Failure Analysis

- **403-1. Review of OEM Service Bulletins (Find Connections to Local Failures)**
- **403-2. Information gathering**
- **403-2. Component analysis**
- **403-3. Interpretation of statistics (e.g. MTBF, etc.)**

404. Predictive Maintenance

- **404-1. Introduction to vibration analysis**
- **404-2. Lubrication sampling**
- **404-3. Thermal imaging scans**
- **404-4. Engineering or vendor discussion / consultation**

Abbreviations and acronyms

AC	alternating current
APTA	American Public Transportation Association
ASCII	American Standard Code for Information Interchange
ATU	Amalgamated Transit Union
avg	average
BART	Bay Area Rapid Transit
CMOS	complementary metal–oxide–semiconductor
CTA	Chicago Transit Authority
DC	direct current
DIP	dual inline package
DMM	digital multimeter
ELES	elevator/escalator
EMT	electrical metallic tubing
Hg	mercury
IBEW	International Brotherhood of Electrical Workers
IC	integrated circuit
LSB	least significant bit
MARTA	Metropolitan Area Rapid Transit Authority (Atlanta)
MRL	machine room-less (elevators)
MSB	most significant bit
MSDS	material safety data sheets
MTBF	mean time between failures
NEC	National Electrical Code
NTC	negative temperature coefficient
NYCT	New York City Transit
PLC	programmable logic controller
PPE	personal protective equipment
psi	pounds per square inch
psia	psi absolute
psig	psi gauge
PTC	positive temperature coefficient
RC	resistor-capacitor
RCL	resistor-capacitor-inductor
RL	resistor-inductor
rms	root mean square
RtK	right to know
SCR	silicon-controlled rectifiers
SEIU	Service Employees International Union
SEPTA	Southeastern Pennsylvania Transit Authority
TTL	transistor-transistor logic
TWU	Transport Workers Union
UJT	unijunction transistor
VOM	volt/ohm meter
vinst	instantaneous voltage
vpp	voltage peak to peak
WMATA	Washington Metropolitan Area Transit Authority