

Appendix A

**WORK PROCESS SCHEDULE
Elevator Constructor Mechanic
O*NET-SOC CODE: 47- 4021.00 RAPIDS CODE: 0173**

This schedule is attached to and a part of these Standards for the above identified occupation.

1. TERM OF APPRENTICESHIP

The term of the occupation shall be four years with an OJL attainment of 8000 hours supplemented by the required hours of related instruction.

2. RATIO OF APPRENTICES TO JOURNEYWORKERS

One (1) apprentice may be employed in each shop department, and/or jobsite employing a qualified journeyworker.

3. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on a percentage of the current journeyworker wage rate.

4 Year Term Example:

1 st	6 months + hours = ____	2 nd	6 months + hours = ____
3 rd	6 months + hours = ____	4 th	6 months + hours = ____
5 th	6 months + hours = ____	6 th	6 months + hours = ____
7 th	6 months + hours = ____	8 th	6 months + hours = ____

4. SCHEDULE OF WORK EXPERIENCE (See attached Work Process Schedule)

The Sponsor may modify the work processes to meet local needs prior to submitting these Standards to the appropriate Registration Agency for approval.

5. SCHEDULE OF RELATED INSTRUCTION (See attached Related Instruction Outline)

Appendix A

WORK PROCESS SCHEDULE Elevator Constructor Mechanic O*NET-SOC CODE: 47-4021.00 RAPIDS CODE: 0173

APPROXIMATE HOURS

INTRODUCTION TO ELEVATORS **1000**

ELEVATOR HISTORY AND BASIC SAFETY

- Identify job hazards
- What proper safety equipment to wear and use
- Common sense safety around elevators and escalators
- Fundamentals of first aid & material safety data sheet information
- Avoiding electric shock, ground fault circuit interrupters
- Codes that apply to the elevator industry
- Demonstrate proper lift techniques
- Perform lockout/tagout procedure as described in the Elevator Industry Field Employees' Safety Handbook

BASIC PRINT READING

- Read prints
- Survey the hoistway for new installation and modernization
- Convert to meter equivalents
- Identify proper use of hardware during daily work routine
- Identify course and fine thread type bolts. Demonstrate the proper identification and grade of imperial bolts

HANDLING MATERIAL & TOOLS/RIGGING & HOISTING

- Safety Procedures
- Properly handle and store all tools
- Tie and identify knots, bends and hitches
- Safety procedures for hoisting heavy equipment
- Building a safe working platform & scaffolding
- Use all safety devices
- The proper method of unlocking the hoistway door using two different types of door unlocking devices
- Demonstrate use of digital multimeter showing proper settings for measuring AC voltage, DC voltage and resistance
- Perform a mousing of an eye hook
- Demonstrate all hand hoisting signals

INSTALLING ELEVATOR COMPONENTS

1000

PIT EQUIPMENT

- Safety Procedures
- Introduction to the pit components and their purpose
- Install pit equipment: buffers, compensating sheaves, limit switch assembly, spring or oil buffers, compensating ropes and chains
- Testing of pit equipment for proper operation
- Determine the proper run-by- clearance of the car and counterweight
- Using either a threaded or grooved pipe, properly connect two pieces of pipe
If using a grooved pipe connection, are the seals made for oil use?
- Using buffer data plate information, identify and choose the proper oil for buffer use and check oil level and fill as necessary. Check for proper test tag and record date of last test

GUIDE RAILS

- Safety Procedures
- Prepare rails and rail runs
- Build templates, drop lines and plumb hoistways of single, multiple or corner post installations
- Install guide rails
- Use a rail gauge and align rails
- Proper use of fall protection, proper care and use of equipment
- Jobsite requirements for properly storing rail guides until they can be installed
- Demonstrate proper sizing of rail equipment to be used and the proper procedure for determining size
- Using a vixen file or other equipment, clean and file rail surfaces to eliminate possible knocking

MACHINE ROOM EQUIPMENT

- Safety Procedures
- Layout and properly align & set equipment
- Properly align sheaves, tracks and gears
- Offset roping
- Calibrate and test
- Demonstrate proper inspection and maintenance procedures for the equipment

HOISTWAY EQUIPMENT

- Safety Procedures
- Assemble car and counterweight sling
- Why elevators use counterweights
- Proper handling & storage of wire ropes
- Plan a rope run and learn other methods of installing and reroping
- Properly install vinyl tile floor covering inside an elevator

MAINTENANCE PRACTICES AND TESTING

GENERAL MAINTENANCE PROCEDURES

1000

- Safety Procedures
- Cleaning and lubrication
- Assembling of the car frame, platform and safeties
- Wire rope hitches & related hardware
- Inspection of the hoist and governor ropes
- Identify all elevator controller components and their operation.
- Proper care of door operator unit and belt driven hydraulic power unit
- Become familiar with American Society of Mechanical Engineers A17.1 code section pertaining to general and specific maintenance requirement of elevators and escalators

MAINTENANCE OF TRACTION ELEVATORS

- Safety Procedures
- Governor speed calibration and test
- Brake inspection, proper lubrication and adjustment
- 5-year safety test
- Installation of a motor brush
- Maintenance Control Plan

MAINTENANCE OF HYDRAULIC ELEVATORS

- Safety Procedures
- Annual hydraulic test
- Replacement of a hanger roller and the proper adjustment of the up thrust roller
- Perform examination of the hydraulic pumping unit and note deficiencies
- Perform inspection of the hoistway and pit
- Perform a test of the Firefighters Service

MAINTENANCE OF ESCALATORS AND MOVING WALKS

- Safety Procedures
- Clean and lubricate
- Handrail slippage
- Maintenance on equipment
- Repair/replacement of equipment

ELECTRICAL

1000

- Procedures for working safely with electricity
- Principle on which all electrical concepts are based
- What is electricity and where does it come from?
- Read a wiring diagram symbol and apply it to the equipment on the job
- Sequence of operation of individual circuits such as starting, stopping car and hall all cancellation and direction selection
- Troubleshoot particular circuits that are malfunctioning
- Locate and repair electrical problems such as ground, opens, defective contacts and coils
- Troubleshoot electrical problems with confidence
- Relay logic

ELEVATOR DOORS AND EQUIPMENT **300**

ELEVATOR DOORS AND EQUIPMENT

- Safety Procedures
- Proper terminology for doors and relating equipment
- Difference between door types and the reasons for choosing to install each type
- Install car and hoistway entrances and door equipment accurately
- Install & adjust elevator doors, gates for passenger, freight & dumbwaiter
- Final Adjustments and Maintenance
- Passenger & freight door, gate repairs and replacements
- Door Operators, repair, replace and adjustments
- Door protective devices and troubleshooting

TRACTION ELEVATORS: MOTORS, **1400** **MOTOR CONTROL AND FAULT FINDING**

- Safety Procedures
- Identify motor components and its function in AC and DC motors
- Gearless machines
- Cleaning and lubrication
- Learn how to check bearings and replace
- Testing and replacing motors, generators, bearings, sheaves and drivers
- Elevator related circuits and basic circuit analysis
- Converting AC to DC Power
- Testing procedures
- Turn and undercut a commutator
- Test shunt and series field coils
- Understand Braking

ELECTRICAL WIRING AND EQUIPMENT **300**

- Safety Procedures
- Read and understand a Code Requirement look up in National Fire Protection Association – 70, repair and replacement of traveler in existing hoist ways
- Terminology for various tools and electrical equipment
- Plan and install raceway and conduit
- Bend conduit
- Plan wiring and pulling wires safely and efficiently
- Accurately prepare and install traveling cables
- Bonding and grounding equipment
- Prepare the elevator for running operation

HYDRAULIC AND INSTALLATION **400**

- Safety Procedures
- Complete a pressure test
- Identify the major components of a hydraulic system and each function
- Drill a hole for a hydraulic jack
- Properly install and plumb the casing & jack with specific tools
- Layout a pipe run and connections to power unit and jack

- Understanding hydraulic theory and valve operation
- Adjust the valves for proper operation
- Troubleshoot and isolate system problems

BASIC ELECTRONICS AND FUNDAMENTALS

600

BASIC ELECTRONICS AND SOLID STATE

- Terminology and safety equipment used on electronic devices
- Binary & hexadecimal systems are related to digital circuitry
- Capacitors and capacitance are used on elevator equipment
- Inductance and inductors are used in circuits
- How a semi-conductor works
- Diode, zener diodes, photodiodes and light emitting diodes
- Understanding transistors and how they operate
- How SCR's are operated and used in elevator circuits
- Various digital gates and their function
- The functions of integrated power supplies
- Different configurations and uses of the Op Amp

MACHINERY TROUBLESHOOTING, ROPE REPLACEMENT

400

ELEVATOR ROPE REPLACEMENT

- Safety Procedures
- The terminology associated with elevator rope replacement
- Inspecting for defective rope, selector tape & cable
- Staging and routing ropes, tapes & cables
- Shackling and socketing
- The inspection of sheaves to see if they are in sufficient condition to put on new ropes
- How to determine the right ropes to order
- Proper handling of wire rope so that it is not damaged prior to installation
- Procedure to properly hang ropes

MACHINERY TROUBLESHOOTING/REPAIR

- Safety Procedures
- Maintenance and troubleshooting for common problems associated with wire ropes and sheaves
- The different machinery types commonly found and some older systems no longer installed, but still in use in mechanical driving systems
- Troubleshooting methods, the importance of proper diagnosis, and the planning, communication and safety aspects of the repair or replacement of mechanical equipment
 - Components found on elevator machinery and some common methods for the proper repair, replacement and adjustment of these components
 - Components commonly found on elevator installations that include governors, tensions and weight frames, car frames and platforms, safeties and release carriers, guide assemblies, buffers and mechanical selector systems
- The proper testing and lubrication of repaired and/or replaced machinery before returning the equipment back to service

ESCALATORS AND MOVING WALKS **300**
ESCALATORS AND MOVING WALKS

- Safety Procedures
- Identification of escalator & moving walk components
- Familiarization of the American Society of Mechanical Engineers A17.1 and American Society of Mechanical Engineers A17.3 code relating to escalators and moving walks
- Installation of an escalator
- Prepare the escalator for running operation
- Inspection & testing

ACCESSIBILITY **300**
ACCESSIBILITY

- Safety Procedures
- Applicable code
- Installation of a stairlift, vertical platform lifts (VPL) and inclined platform lift (IPL).
- Installation of a private residence elevator.

TOTAL HOURS **8000**

RELATED INSTRUCTION OUTLINE
Elevator Constructor Mechanic
O*NET-SOC CODE: 47-4021.00 RAPIDS CODE: 0173

	APPROXIMATE HOURS
YEAR 1	
COURSE 1: INTRODUCTION TO ELEVATORS	
Unit 1: ELEVATOR HISTORY AND BASIC SAFETY	35
1. History of Elevators	
2. Elevator Industry Organizations	
3. Anatomy of An Elevator	
4. Types of Elevators and Driving Machines	
5. Escalators and Moving Walks	
6. Applicable Codes and Publications	
7. Work of the Elevator Professional	
8. General Safety	
9. Component Installation Safety Practices	
10. Service Safety	
11. Terminology	
Unit 2: BASIC PRINT READING	24
1. Print Terminology	
2. Drawing to Scale	
3. Introduction to Installation Drawings	
4. Detail Drawing and Layout	
5. Fits, Tolerances and Fasteners	
Unit 3: HANDLING MATERIAL & TOOLS / RIGGING & HOISTING	20
1. Handling Materials and Tools	
2. Rigging and Hoisting	
3. Handling Material – Storage on the Jobsite	
COURSE 2: BASICS OF INSTALLING ELEVATOR COMPONENTS	
Unit 4: PIT EQUIPMENT	25
1. Introduction and Pit Construction	
2. Buffers	
3. Governor Rope Tension Sheaves	
4. Compensating Equipment	
5. Tension Sheaves for Selectors and Floor Controllers	
6. Limit Switches	
Unit 5: GUIDE RAILS	10
1. Guide Rail Construction and Code Requirements	
2. Plumbing the Hoistway	
3. Guide Rail-Bracket Fastenings and Setting	
4. Installing the Guide Rails	
5. Guide Rail Gauging, Aligning, and Filing	
Unit 6: MACHINE ROOM EQUIPMENT	30

1. Machine Installation	
2. Machine Room Accessories and Installation	
3. Hydraulic Components	
Unit 7: HOISTWAY EQUIPMENT	25
1. Car and Counterweight Assemblies	
2. Elevator Rope and Roping	
3. Hydraulic Driving Components	
4. Top of Car Equipment	
5. Operating Fixtures and ADA	

TOTAL HOURS	169
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YEAR 2

COURSE 3: MAINTENANCE PRACTICES AND TESTING

Unit 8: GENERAL MAINTENANCE PRACTICES	22
1. Lubrication	
2. Bolting Practices	
3. Elevator Ropes	
4. Wiring Diagrams	
5. Belts and Chains	
6. Code Requirements	
7. Testing Requirements	
Unit 9: MAINTENANCE OF TRACTION ELEVATORS	30
1. Introduction	
2. Maintenance Inside the Car and Outside the Hoistway	
3. Maintenance in Machine Room	
4. Top of Car and Hoistway Maintenance	
5. Pit and Bottom of Car Maintenance	
6. Maintenance Code Requirements	
7. Tests	
Unit 10: MAINTENANCE OF HYDRAULIC ELEVATORS	20
1. Introduction	
2. Maintenance Inside the Car and Outside the Hoistway	
3. Maintenance in Machine Room	
4. Top of Car and Hoistway Maintenance	
5. Pit and Bottom of Car Maintenance	
6. Maintenance Code Requirements	
7. Tests	
Unit 11: MAINTENANCE OF ESCALATORS AND MOVING WALKS	25
1. Introduction	
2. Exterior Maintenance	
3. Interior Maintenance	
4. Testing	

COURSE 4: ELECTRICAL THEORY**65**

1. Introduction / Safety
2. Atomic Structure
3. Electrical Quantities and Ohm's Law
4. Static Electricity
5. Magnetism
6. Resistors
7. Series Circuits
8. Parallel Circuits
9. Combination Circuits
10. Measuring Instruments
11. Using Wire Tables and Determining Conductor Sizes
12. Batteries and Other Sources of Electricity
13. Magnetic Induction
14. Alternating Current
15. Inductance in AC Circuits
16. Capacitors
17. Capacitance in AC Circuits
18. Three-Phase Circuits Single-Phase Transformers
19. Single-Phase Transformers
20. National Electric Code (NEC)

TOTAL HOURS**162****YEAR 3****COURSE 5: ELEVATOR DOORS AND EQUIPMENT**

Unit 12: ELEVATOR DOORS AND EQUIPMENT

20

1. Door Types
2. Preparation of Shaft and Clearances
3. Installation of Sliding Passenger Elevator Entrances
4. Hoistway Equipment
5. Car Equipment
6. Swing Hoistway Doors
7. Types of Freight Doors
8. Preparation of Site
9. Freight Door Systems
10. Car Gate System
11. Retiring Cam System
12. Controller
13. Final Adjustments and Maintenance
14. Dumbwaiter Overview
15. Preliminary Drawings and Field Conditions
16. Anatomy of Dumbwaiter Doors and Installation
17. Anatomy of Dumbwaiter Gates and Installation
18. Dumbwaiter Door Interlocks and Cams
19. Maintenance, Troubleshooting and Replacement

COURSE 6: TRACTION ELEVATORS: MOTORS, MOTOR CONTROL AND FAULT FINDING

PART 1: AC AND DC MOTORS, GENERATORS AND MOTOR CONTROL **65**

1. AC Motors
2. DC Motors
3. Motor Control
4. Regulators
5. Gearless Machines
6. Braking
7. Electrical Fault Finding

PART 2: ELEVATOR RELATED CIRCUITS AND BASIC CIRCUIT ANALYSIS **40**

1. Elevator Related Circuits
2. Schematic Circuit Diagrams
3. Testing Instruments and Procedures
4. Sequence of Investigation

COURSE 7: ELECTRICAL WIRING AND EQUIPMENT

UNIT 13: CONSTRUCTION WIRING AND EQUIPMENT **20**

1. Planning and Installation
2. Raceway and Conductor Installation
3. Traveling Cable Installation
4. Powering Up the Elevator

TOTAL HOURS **145**

YEAR 4

COURSE 8: HYDRAULIC THEORY AND INSTALLATION

UNIT 14: HYDRAULICS **35**

1. Basic Hydraulic Theory
2. Drilling and Casing the Jack Hole
3. Installing the Jack and Components
4. Installing and Piping the Hydraulic Machines
5. Guide Rails, Car Slings, Entrances and Doors, and Wiring
6. Car Enclosure and Operation

COURSE 9: BASIC ELECTRONICS AND FUNDAMENTALS

UNIT 15: INTRODUCTION TO ELECTRONICS AND SOLID STATE **40**

1. Basic Concepts
2. Resistors
3. Capacitors
4. Switches, Keyboards and Relays
5. Magnetic Components
6. Miscellaneous Passive Components and Technology Trends
7. Discrete Semiconductors, Definitions and General Information
8. Diode Manufacture
9. Diode Characteristics and Specifications
10. Diode Applications
11. Thyristors (AC Switches)
12. Bipolar Transistors

13. Field-Effect Transistors (FETs)
14. Light-Emitting Diodes (LEDs)
15. LED Displays
16. Other Display Technologies
17. Opt-Couplers (Opt-Isolators)
18. Solid-State Relays (SSRs) and Optoelectronic Technology Update

COURSE 10: MACHINERY TROUBLESHOOTING AND ROPE REPLACEMENT

UNIT 16: ELEVATOR ROPE REPLACEMENT 6

1. Wire-Rope Terminology
2. Procedures for Inspection and Criteria for Rope Removal
3. Additional Inspections Prior to Re-Roping
4. Re-Roping
5. Field Maintenance and Troubleshooting

UNIT 17: MACHINERY TROUBLESHOOTING/REPAIR 24

1. Mechanical Driving Systems
2. Troubleshooting, Diagnosis and Planning
3. Repair and Replacement of Machinery Components
4. Related Mechanical Equipment
5. Testing and Lubrication of Equipment

COURSE 11: ESCALATORS AND MOVING WALKS

UNIT 18: ESCALATORS AND MOVING WALKS 20

1. Safety
2. Escalator/Moving Walk Familiarization and Safety
3. Escalator/Moving Walk Safety Code
4. Introduction to Escalator Installation Procedure
5. Truss Installation
6. Truss Adjusting and Anchoring
7. Installing Center Line on Truss
8. Upper and Lower Carriage Installation
9. Controller Installation
10. Step and Handrail Installation
11. Final installations, Tests and Inspections
12. Maintenance Requirements

COURSE 12: ACCESSIBILITY

UNIT 19: INTRODUCTION TO THE VERTICAL TRANSPORTATION INDUSTRY 20

1. Vertical Transportation History
2. Organization Relevant to the Vertical Transportation Industry
3. National Applicable Codes and Regulations
4. Accessibility Industry Glossary of Terms
5. Types of Accessibility and Residential Equipment
6. General Safety
7. Introduction to Basic Electricity
8. Print Reading
9. Installation

TOTAL HOURS 145