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Maintenance, Inspection, and Testing of Electric and Hydraulic Elevators



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Mechanical Equipment Group
Infrastructures Services Division

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MAINTENANCE, INSPECTION, AND TESTING OF ELECTRIC AND HYDRAULIC ELEVATORS

1. INTRODUCTION**1.1 Purpose**

There are over 125 elevators at various Bureau of Reclamation (Reclamation) pumping plants, powerplants, dams, office buildings, tunnels, and visitor facilities. The safety of these elevators is an ongoing concern of Reclamation. While elevators are generally considered to be an extremely reliable and safe means of vertical transportation, it is only by a thorough program of inspection and testing that they can be considered to be so. A malfunctioning elevator system potentially may cause loss of life or serious injury. Many of the elevator systems at Bureau facilities are aging and may not have had a reliable record of inspection and maintenance. Many of these elevators may lack some of the safety features that are required by code to build an elevator today.

The primary purpose of this document is to assert that conformance to the elevator safety codes developed by the American Society of Mechanical Engineers (ASME) is required. The Bureau of Reclamation Safety and Health Standards (BRSHS) require that permanent elevators be inspected and maintained in accordance with the current editions of ASME A17.1 - "Safety Code for Elevators and Escalators" (the Code) and ASME A17.2 - "Inspectors' Manual for Elevators and Escalators." In addition, BRSHS requires testing and certifying elevators in accordance with the Code. Much of the information contained in this document was obtained from the ASME codes and related publications.

1.2 Pertinent ASME Elevator Codes

The ASME Elevator Codes and publications that are pertinent to the inspection and maintenance of Reclamation elevators are as follows:

ASME A17.1 – "Safety Code for Elevators and Escalators" – covers installation requirements for new elevators, as well as maintenance and test requirements for existing equipment.

ASME A17.2 - "Inspectors' Manual for Elevators and Escalators" – is a guide that provides recommended procedures for inspection and testing of equipment to comply with A17.1 and A17.3. (A17.2.1 pertains to Electric Elevators; A17.2.2 pertains to Hydraulic Elevators)

ASME A17.3 – "Safety Code for Existing Elevators and Escalators" – covers retroactive requirements for existing elevators and escalators. Establishes minimum standards for all elevator equipment regardless of the installation date. This code takes into account the existing building structural conditions that would limit the feasibility of bringing the elevator up to current ASME A17.1 requirements.

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ASME A17.4 – “Guide for Emergency Evacuation of Passengers from Elevators” – establishes procedures for the safe evacuation of passengers from stalled elevators.

ASME A17.1 Handbook and ASME A17.1 Interpretations – provide assistance for understanding and gaining insight into the Code requirements and rules.

ASME QEI-1 - establishes the requirements for the qualification, duties, and responsibilities of inspectors and inspection supervisors engaged in inspection and testing.

The Code requires that *maintenance, repair, and replacements* only need to conform to the Code at the time of the original installation. However, *alteration* of the elevator is required to conform to the Code at the time of the alteration. New additions to the Code are issued approximately every 3 years, along with intermediate supplements, which are issued as needed.

Alteration is defined in the Code as: "*any change to equipment, including its parts, components, and/or subsystems, other than maintenance, repair, or replacement.*"

Maintenance is defined in the Code as: "*a process of routine examination, lubrication, cleaning, and adjustment of parts, components, and/or subsystems for the purpose of ensuring performance in accordance with the applicable Code requirements.*"

Repair is defined in the Code as: "*reconditioning or renewal of parts, components, and/or subsystems necessary to keep equipment in accordance with applicable Code requirements.*"

Replacement is defined in the Code as: "*The substitution of a device or component and/or subsystems, in its entirety, with a unit that is basically the same as the original for the purpose of ensuring performance in accordance with applicable Code requirements.*"

2. GENERAL MAINTENANCE

A strong preventive maintenance program, combined with scheduled testing, will help to ensure future safety, performance, and economy of Reclamation elevators.

When determining the maintenance intervals, take into account the manufacturer's recommendations, how often the elevator is used, the severity of equipment loading, the age and wear of the equipment, the equipment's operating environment, and the inherent quality of the equipment.

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All maintenance, repairs, replacements, and alterations must conform to the applicable section of the Code. At no time, except when necessary during tests and inspections, may required safety devices or electrical protection devices be made ineffective. In the event that these devices are made temporarily ineffective, they must be returned to full operating condition before the elevator can be returned to service.

2.1 Scope of Preventive Maintenance

The scope of the preventive maintenance program shall be comprehensive and shall include, at a minimum:

- Inspection
- Adjustments
- Lubrication
- Repairs and replacements (including light bulbs/lamps)
- Housekeeping/cleaning
- Recordkeeping

The program shall maintain the elevator to run at rated speed, rated capacity, desired door open/close timing, designated floor stops, required floor leveling parameters, etc.

2.2 Maintenance Personnel

In accordance with the Code, maintenance, repairs, or replacements are to be performed only by persons trained to perform these operations on the equipment.

2.3 Recordkeeping

A complete log must be kept that contains records of all maintenance, adjustments, repairs, replacement, etc., performed on the elevator. The log must include the dates, names of participating personnel, and description of tasks performed, including tests and inspections, reports, trouble calls, corrective action, recommendations, or any other incidents related to the elevator.

Manufacturer's data and drawings for the elevator equipment shall be accessible and maintained to reflect the current state of the equipment. Important data such as manufacturer names, part numbers, serial numbers, sizes, and types shall be readily accessible. Any pertinent service bulletins shall also be kept.

Checklists for the scheduled preventive maintenance tasks shall be developed and kept to ensure that these tasks are performed.

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2.4 Safety

The following practices shall be observed, at a minimum, during maintenance, inspection, or testing procedures:

- All safety devices must be in operational condition.
- Lockout/tagout procedures must be followed if maintenance procedures require that the equipment not be operated.
- Ensure that personnel performing maintenance, inspection, and testing tasks wear clothing that is not loose fitting and that they are provided with proper protective equipment, such as safety shoes, hard hats, eye protection, and hand protection.
- Provide barriers and signage, where applicable, especially at hoistway doors.
- Upon completion of work, remove any jumper wires that were used.
- It is possible that the elevator pit may be designated a "Permit Required Confined Space." The additional required safe procedures must be attended to in these cases.
- Provide proper lighting.
- Determine that adequate refuge space exists above and below the car.
- Ensure the working area is clean and dry.

(More detailed safety procedures can be found in publications such as the *Elevator Industry Field Employees' Safety Handbook*.)

3. INSPECTIONS**3.1 General**

ASME A17.1 recommends that periodic inspections be performed at 6-month intervals by a Qualified Elevator Inspector, as defined by ASME QEI-1. The inspections are performed to determine whether the existing equipment conforms to the Code.

In some cases, such as with elevators that are rarely or never used, where the ambient conditions are good (not tending or likely to degrade and damage equipment), the recommended inspection intervals could be extended up to 12 months, as long as

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agreement is reached and documented among facility managers, safety engineers, and other responsible personnel. Conversely, the recommended inspection interval could be shortened for some or all of the equipment, if deemed necessary.

3.2 Areas of Inspection

Specific items and equipment to be inspected under each of the following areas are listed in the Code and described in ASME A17.2.1 (for *electric* elevators) and ASME A17.2.2 (for *hydraulic* elevators).

The areas of inspection include:

- a. Inside car – door reopening device, stop switches, operating and control devices, car floor/landing sill, lighting, car emergency signal, car door, door closing force, power opening/closing of doors, vision panels, car enclosure, emergency exit, ventilation, signage, rated load, platform area, data plate, emergency power, restricted door opening, car ride, door monitoring, stopping accuracy
- b. Machine room – access, head room lighting, receptacles, machine enclosure space, housekeeping, ventilation, fire suppression, pipes, wiring, ducts, guarding of equipment, numbering/labeling, disconnecting means, controller wiring/fuses/grounding, static control, overhead beam, machines and machine brakes, motor-generators, regenerated power, alternating current (AC) drives, sheaves, rope fastenings, terminal stopping devices, slack rope devices, governor, safeties, data plate

Hydraulic elevators require inspection of their unique additional equipment and systems such as: heating, hydraulic power unit, relief valves, control valve, tanks, flexible hoses/fittings, supply line, shutoff valve, hydraulic cylinder, fluid loss record, pressure switch, data plate, governor, recycling operation

- c. Top of car – stop switch, light, outlet, operating device, refuge space, counterweight clearance, sheaves, normal/final terminal stopping devices, broken rope/chain/tape switch, leveling devices, data plate, emergency exit, counterweight, counterweight buffer, counterweight safeties, floor numbering, hoistway construction, smoke control, pipes/wiring/ducts, windows/projections/recesses/ setbacks, clearances, multiple hoistways, traveling cables/junction boxes, door equipment, car frame, guide rails, guide rail alignment, guide rail fastenings, governor/traction/compensation ropes, rope fastening devices

Hydraulic elevators require inspection of their unique additional equipment and systems such as: terminal speed limiting devices, anti-creep limiting devices, speed test, suspension rope, governor rope releasing carrier, governor rope, wire rope fastening/hitch plate, slack rope device, traveling sheave, counterweight

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- d. Outside the hoistway - platform guard, hoistway doors, vision panels, hoistway door locking devices, access, power closing of hoistway doors, sequence operation, enclosure, parking devices, emergency access, separate counterweight hoistway, standby power selection switch, emergency doors in blind hoistways
- e. Pit - access, lighting, stop switch, condition, clearance, runby, buffers, normal/final terminal stopping devices, traveling cables, governor rope, governor rope tension, compensating chains/ropes/sheaves, car frame/platform, car safeties, car guides

Hydraulic elevators require inspection of their unique additional equipment and systems such as their plunger and cylinder.

- f. Firefighters' emergency operation.

4. TESTS**4.1 Testing**

The Code requires periodic testing of elevators witnessed by a Qualified Elevator Inspector (as defined by ASME QEI-1).

Test certifications may be issued by various public jurisdictions, such as State, county, or city elevator commissions or boards, or by private entities.

Metal test tags are required to be installed in the machine room for the Category 5 (full load) *electric* elevator test and for the Category 1, 3, and 5 *hydraulic* elevator tests.

4.2 Test Intervals

The recommended interval for Category 1 tests is 12 months, for Category 3 tests is 36 months, and for Category 5 tests is 60 months.

In some cases, such as with elevators that are rarely or never used, where the ambient conditions are good (not tending to degrade and damage equipment), and where the past maintenance has been of high quality, consideration may be given to performing the Category 1 tests in conjunction with the Category 5 tests. In these limited cases where the recommended intervals are extended, agreement shall be reached and documented among facility managers, safety engineers, and other responsible personnel.

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4.3 Electric Elevator Tests

The Code provides general descriptions of the Category 1 and 5 tests for electric elevators. More detailed descriptions are provided in ASME A17.2.1.

4.3.1 Category 1 Tests - Electric Elevators

The Category 1 test requirements for *electric* elevators generally can be characterized as "no-load/low-speed," and involve the following equipment:

- Oil buffers
- Safeties
- Governor
- Standby power operation
- Firefighters' service
- Door closing force
- Final and normal stopping devices

4.3.2 Category 5 Tests - Electric Elevators

The Category 5 test requirements for *electric* elevators generally can be characterized as "rated-load/rated-speed," and involve the following equipment:

- Oil buffers
- Safeties
- Governor
- Braking system
- Emergency terminal stopping and speed-limiting devices
- Standby power operation
- Inner landing zone
- Power opening of doors
- Emergency stopping distance
- Leveling zone and leveling speed

4.4 Hydraulic Elevator Tests

The Code provides general descriptions of the Category 1, 3, and 5 tests for hydraulic elevators. More detailed descriptions are provided in ASME A17.2.2.

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4.4.1 Category 1 Tests - Hydraulic Elevators

The Category 1 test requirements for *hydraulic* elevators involve the following equipment:

- Relief valve setting and system pressure
- Flexible hose and fitting
- Hydraulic cylinder leak test
- Standby power operation
- Firefighters' service
- Power operation of doors
- Normal and final terminal stopping devices
- Emergency terminal speed-limiting device
- Emergency terminal stopping device
- Pressure switch
- Oil buffer, Safety, Governor (if provided)
- Low oil test

4.4.2 Category 3 Tests - Hydraulic Elevators

The Category 3 test requirements for *hydraulic* elevators involve the following equipment:

- Unexposed portions of pistons
- Pressure vessels (hydrostatic test)

4.4.3 Category 5 Tests - Hydraulic Elevators

The Category 5 test requirements for *hydraulic* elevators involve the following equipment:

- Oil buffer (if provided)
- Safety (if provided)
- Governor (if provided)
- Coated ropes (if provided)
- Rope fastening on pistons (if provided)
- Overspeed valve

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5. ADDITIONAL ITEMS**5.1 Pre-1970 Hydraulic Elevators**

The Code did not require hydraulic elevators to possess a safety bulkhead until 1970. Hydraulic elevators installed before 1970 shall be scrutinized and frequently checked for leakage. It is recommended that these elevators have their cylinders replaced or, at minimum, that the elevator jack be provided with an external safety device to arrest the jack from uncontrolled descent.

In addition, poor insulation or lack of cathodic protection of the hydraulic cylinder may significantly shorten the life of the elevator system and render it unsafe, even if the cylinder was installed with a safety bulkhead. The use of noncorroding plastic liners is a recent design development. Most older hydraulic elevators were installed with steel liners, which are more susceptible to corrosion attack.

5.2 Americans with Disabilities Act - Accessibility Guidelines (28 CFR Part 36 Appendix A) (ADAAG)

The requirements of ADAAG include provisions that promote the safety and accessibility of disabled persons who use elevators. Reclamation elevators that are used by the general public or disabled facility personnel shall be considered for upgrade to meet ADAAG.

5.3 Prohibition of Governor Rope Lubrication

To avoid over-lubrication of the governor rope, which could lead to failure of the governor to activate the safety and arrest an overspeeding car, the Code prohibits the lubrication of the governor ropes after installation.

5.4 Rope Retirement Criteria

The Code and the Inspector's Manual provide specific criteria for when the replacement of the governor, suspension, and compensation ropes are required. The ropes must be clean enough to effectively inspect them for breaks, abrasion, corrosion, wear, reduced diameter, etc.

5.5 Code Data Plate

ASME A17.1 requires that a data plate, indicating the Code edition in effect at the time of installation and the Code edition at the time of any alteration, be located in plain view and attached to either the main line disconnect or the controller. The Code edition(s) indicated on the data plate govern the testing and inspection requirements.

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5.6 Acceptance Inspections and Tests of New or Altered Installations

ASME A17.1 requires that new or altered installations of both electric and hydraulic elevators be subjected to acceptance inspections and tests before being placed in service. The series of inspections and tests for new installations is comprehensive (inside car, machine room, top of car, outside hoistway, pit, and firefighters' emergency operation) and is detailed in the Code. The series of inspections and tests for altered installations generally involves those items that were affected and depends on the nature and effects of the alterations. These inspections and tests are also detailed in the Code.

5.7 Escalators, Moving Walks, Dumbwaiters, and Special Application Elevators

ASME A17.1 provides the requirements for testing and inspecting escalators and moving walks.

The requirements for dumbwaiters, material lifts, and special application elevators such as inclined, limited-use/limited-application, rooftop, special purpose personnel, and construction are generally the same as standard elevators and are detailed in ASME A17.1, which lists pertinent exceptions and additions.

5.8 Personnel Hoists Not Covered by ASME A17.1

ASME A17.1 does not specifically cover the equipment associated with personnel hoists that are within the scope of the following codes (among others): ANSI 10.4, ASME A90.1, ANSI A92, or ASME 120.1. The personnel hoists covered under these codes are generally temporary or mobile personnel hoisting systems that are not a permanent part of buildings and are used mainly during construction, demolition, or maintenance operations.

6. RESOURCES AND PUBLICATIONS

In addition to the ASME Code publications, other publications are available as references for the maintenance, inspection, and testing of elevators:

Elevator Maintenance Manual, by Zack McCain. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36606

Elevator Field Maintenance, by Zack McCain. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36660

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Inspection Handbook, by Zack McCain. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile AL 36660

Hydraulic Elevator and Escalator Maintenance Log. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36660.

Electric Elevator and Escalator Maintenance Log. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36660

Elevator World Source Directory. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36660

Elevator Industry Field Employees' Safety Handbook. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36660

Elevator Maintenance - A Guide to Specifying and Obtaining Services by Contract. Published by the Property Management Association, Inc., 8811 Colesville Road, Suite G106, Silver Spring, Maryland 20910

7. LIST OF APPENDICES

Appendix A – Glossary of Terms

Appendix B – Minimum Maintenance Requirements for Electric Traction Elevators

Appendix C – Minimum Preventive Maintenance Requirements for Hydraulic Elevators

Appendix D – Typical Guidelines for Full Service Maintenance Agreement for Elevators

Appendix E – Electric Elevator Periodic Test Charts

Appendix F - Hydraulic Elevator Periodic Test Charts

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**Appendix A
GLOSSARY OF TERMS**

Alteration:	Any change to equipment, including its parts, components, or subsystems, other than maintenance, repair, or replacement.
Alarm bell:	An electric bell activated by a pushbutton in the car operating panel, used by passengers to signal for help.
Annunciator:	A device in the car that provides visual and/or audible signal(s) when the elevator car reaches or passes a landing.
Armature:	A revolving part of a direct current (DC) motor or generator.
Ascending car overspeed protection:	A device for (a) detecting overspeed in an ascending car and (b) actuating an emergency brake to decelerate the car during such an event.
Bearing, thrust:	A ball bearing on geared machine worm shaft that absorbs lateral thrust.
Brake:	A component of the elevator machine used to retard or hold the elevator car, load, and counterweight.
Buffer:	A device that stops a descending car or counterweight from traveling beyond its normal limit by absorbing or storing the kinetic energy of the car or counterweight. Buffer types include oil-filled pistons, spring, combination gas-spring and oil piston, and combination mechanical spring and oil piston.
Capacity (rated load):	The load that equipment is designed and installed to lift at the rated speed.
Car, elevator:	A load-carrying unit that includes the platform, enclosure, frame, and door(s).
Car enclosure:	The top and walls of the car.
Car frame (sling):	The frame that supports the car platform and to which the car guides, safety, hoist ropes (or associated sheaves), or hydraulic cylinder plunger are attached.
Car platform:	The load-supporting floor of the car; also supports car enclosure.

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Clearance:	The clear vertical distance between either the bottom of the car and the pit floor (when the car is resting on fully compressed buffers) or the topmost part of the car and any obstruction above the car (when the car is level with the top terminal landing).
Controller:	A device that serves to control the car motion and may include electric motor starter devices and power conversion equipment.
Counterweight:	The steel frame and weights used to counterbalance the car and a percentage of its load.
Designated level:	The main floor or other floor level that best serves the needs of emergency personnel for firefighting or rescue purposes. This is the floor the cars are recalled to when a Phase I Emergency Recall Operation is activated. An <i>alternate level</i> is the floor level that serves as the recall level for a Phase I Emergency Recall Operation if fire is detected at the designated level.
Door reopening device:	The equipment designed to detect an obstruction in the door opening that actuates the door operator to open if an obstruction is detected.
Elevator:	A mechanism for raising and lowering a guided car, serving two or more landings of a structure.
Emergency exit:	An opening in the elevator car that permits evacuation of passengers in an emergency.
Exciter:	A device that supplies voltage to the motor and brake circuits.
Firefighter's service:	A mode of elevator operation initiated after a fire is detected in a building.
Phase I:	The removal of the elevator from normal service by automatic or manual recall of the elevator car to the designated or alternate landing.
Phase II:	The operation and control of the elevator by firefighters, effected by keyswitch.
Fire resistance rating:	The measured time that a material will withstand fire exposure.

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Governor:	A device used to detect overspeed of the car or counterweight and to activate the safety device upon this condition.
Guides:	The equipment attached to the car and counterweight frames at the top and bottom to retain them on the guide rails.
Guide rails:	A steel section, fixed to the hoistway, used to guide the car and counterweight frame.
Hoistway (shaft):	The opening or shaftway through a structure for the travel of an elevator.
Hydraulic jack:	A cylinder equipped with a plunger/piston, which applies the energy provided by a pressurized liquid.
Independent service:	An operating mode in which a car responds only to stops registered on the car operating panel.
Interlock:	A device to prevent: (1) the operation of the driving machine, unless the car door is locked in the closed position; and (2) the opening of the car door from inside the car, unless the car is within the landing zone.
Landing:	The portion of a floor used to discharge and receive passengers or freight.
Landing zone:	A zone extending from 18 inches above to 18 inches below a landing.
Leveling:	The process of vertical alignment of the elevator car floor to the landing floor.
Maintenance:	The process of routine examination, lubrication, cleaning, and adjustment of parts, components, or subsystems for the purpose of ensuring performance.
Machine:	A power unit that provides the energy to raise and lower the elevator car. <i>Electric machine</i> - The energy is provided by an electric motor. It includes the motor, brake, driving sheave/drum, and gearing. The most common are: (1) the <i>geared-traction</i> (geared-drive machine in which the motion of the car is obtained through friction between the hoist ropes and a traction sheave) and (2) the <i>gearless-traction</i>

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types (without intermediate gearing, in which the motion of the car is obtained through friction between the hoist ropes and a traction sheave).

Hydraulic machine - The energy is provided through a hydraulic machine and applied through a hydraulic jack, which is either connected directly to the car (*direct-hydraulic*) or by wire ropes (*roped-hydraulic*).

Machine room:	The location of the elevator machine, controller, and other equipment.
Modernization:	See <i>Alteration</i> .
Motor-generator set:	An AC motor that drives a DC generator to provide power to the DC elevator machine.
Operation:	<p>A method of actuating (starting, stopping, direction) motion control.</p> <p><i>Automatic operation</i> - Car motion started by operating devices (e.g., pushbutton) in the car or at a landing and stopping automatically at landings.</p> <p><i>Group automatic operation</i> - This is an automatic operation of two or more elevators coordinated by a control system that dispatches and stops the first available car in the group that approaches the landing in the corresponding direction.</p> <p><i>Nonselective collective operation</i> - Automatic operation in which all requested stops are made in the order of the landings as they are reached, irrespective of the direction the car is traveling or the order that the calls were made. Each landing is equipped with only one call button.</p> <p><i>Selective collective operation</i> - Automatic operation in which the calls are answered in the order that the landings are reached in each direction of travel. Each landing is equipped with an "UP" and a "DOWN" call button (except the terminal landings, which have only one).</p> <p><i>Single automatic operation</i> - Automatic operation in which the call that is registered first is answered before subsequent calls are addressed.</p>

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Preregister operation - The operator in the car is notified by signal to initiate stops that are registered in advance by pushbuttons in the car or at landings.

Car-switch operation - The operator directly and solely controls the movement of the car by manually operated switch or continuous pressure pushbutton.

Car-switch automatic floor stop operation - Stops are initiated by the operator, and subsequent slowing and stopping is automatic.

Signal operation - The control by which predetermined landing stops are registered. The car stops automatically in succession at these landings, irrespective of the direction of travel or the order that the buttons are actuated.

Continuous pressure operation - The control of car movement requires that buttons or switches be maintained in the actuating position.

Pit:	That portion of the hoistway that extends from the sill of the bottom terminal landing to the hoistway floor.
Position indicator:	A device that indicates the landing position of the elevator car.
Rated speed:	The design speed of the elevator in the up direction with the rated load in the car.
Repair:	The recondition or renewal of parts, components, or subsystems to keep equipment in compliance with Code requirements.
Replacement:	The complete substitution of a device, component, or subsystem with the same or similar equipment to ensure performance in accordance with Code requirements.
Rope:	Wire rope, composed of steel strands. <i>Hoist rope</i> – Supports, raises, and lowers the car and counterweight.

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Compensating rope - Used to counterbalance the weight of the hoist rope on elevators with long travel distances. This rope is normally connected from the underside of the car to the underside of the counterweight. Compensation is sometimes achieved by using chains or other mechanical means.

Governor rope - Used to activate the safety device while driving the speed governor.

Runby: This is the distance between the buffer striker plate on the bottom of the car or counterweight and the striking surface of the associated buffer when the car has reached the terminal landings.

Safety: A mechanical device attached to the car frame or counterweight frame that engages the guide rails to stop and hold the car or counterweight if an overspeed condition is detected.

Seismic switch: A device activated by ground motion that signals an imminent earthquake.

Selector: A device driven by the car motion, used to locate the position of the car and relate that information to the controller.

Sheave: A grooved pulley for wire rope.

Compensating sheave - Used to keep the compensating ropes taut.

Deflector sheave - Used to change the direction of the hoist ropes.

Driving sheave - Part of the electric hoist machine that the car and counterweight hoist ropes pass over.

Overhead sheave - Used to reverse the direction of the hoisting ropes when the machine is located at the bottom of the hoistway.

Secondary sheave - Used to provide an extra traction surface and to provide a double-wrap arrangement around the driving sheave.

2:1 sheave - Used on top of the car and counterweight to double the load capacity.

Stator: An iron core and associated wire coils forming part of the stationary elements of an AC motor.

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Terminal stopping device:	<p><i>Normal</i> - Slows and stops the car automatically at a terminal landing, independent of the normal stopping means.</p> <p><i>Final</i> - Cuts power automatically from the motor and brake (or from a hydraulic machine) when the car has passed a terminal landing.</p>
Travel:	The distance the elevator car travels between the top and bottom landing levels.
Traveling cable:	The set of flexible electrical conductors that connect the car equipment to the control equipment in the machine room. The cable is typically connected to the underside of the car at one end and anchored at a junction box in the hoistway at the other end.
Unintended car movement protection:	A device for: (1) detecting unintended car movement away from the landing with the hoistway door not in the locked position and the car door not in the closed position and (2) for actuating an emergency brake to stop and hold the car during such an event.

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Appendix B
MINIMUM PREVENTIVE MAINTENANCE
REQUIREMENTS FOR ELECTRIC TRACTION ELEVATORS

The following items (as applicable) shall be included requirements of a maintenance contract:

(Note: When items are inspected and found to be defective, broken, out of adjustment, etc., they must be repaired, replaced, or adjusted to meet the requirements of the Code.)

PERFORMED ON A WEEKLY BASIS:

Inspect and lubricate (as required) machinery, sheaves, worm, gear, motor, brake, selector, and controller.

Ride in the car to observe operation of doors, leveling, smoothness, and door reopening devices at each landing. Listen for unusual noises in the car and in the hoistway.

Check all car operating controls, lamps, and gongs. Replace burned-out lamps.

Clean:

- Drip pans (check oil levels of associated equipment)
- Door reopening device photo eye components
- Door tracks and sills
- Lamps and sensors in the car top controller
- Car top
- Machine room
- Pit
- Brushes and commutator
- Controller
- Selector
- Relay connectors
- Contacts

Check operation of the brake and adjust or repair if necessary. Lubricate pivot points.

Inspect governor operation and working parts. Clean and lubricate.

PERFORMED ON A MONTHLY BASIS:

Check and adjust car door operation. Lubricate hangers, rollers, gibs, linkages, and pivot points. Check and adjust door clearances, eccentrics, arm bearings, speed control switches, cables, clutches, chains, and belts. Tighten door drive system points.

Check selector. Clean, adjust, and lubricate components as required.

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Check the car telephone and alarm operations. Repair the alarm system if required.

Check the operation of the limit and safety switches in hoistway and car.

Check the oil level in the car and in the counterweight oil buffers. Add oil as required.

Check the motor brushes and commutators. Check the brushes for tension, seating, and wear (replace or adjust as required). Check commutators for finish, grooving, eccentricity, and mica level - clean, turn, or refinish as required.

Check the car emergency light.

Check the car ventilation system and heater.

Initiate the Phase I firefighter recall service and check for proper operation to a minimum of two floors under Phase II service.

PERFORMED ON A QUARTERLY BASIS:

Check for proper car leveling operation. Adjust if required.

Check and clean the door switch contacts.

Check the door speed control switches.

Inspect the condition of resistors and mounting assemblies.

Check car top and hoistway for loose covers, vanes, or components.

Inspect the traveling cables for damage.

Inspect the brake linings.

Inspect all ropes for wear and lubrication (do not lubricate the governor rope) - replace or lubricate the ropes if required. Clean the governor and hoist ropes. Inspect the rope hitches, fastenings, and shackles - equalize ropes if warranted.

Check the car position sensor drive wheel.

Check decelerations, advances, and accelerations to ensure all cars are matched.

Inspect all parts of the safeties and adjust clearance between the safety jaws and guide rails. Clean all parts and lubricate the pivot points.

MAINTENANCE, INSPECTION, AND TESTING OF ELECTRIC AND HYDRAULIC ELEVATORS

PERFORMED ON A SEMI-ANNUAL BASIS:

Comprehensive inspection - see *Section 3.2* of this document.

Additionally, note the following specific items:

Check for hoist rope wear, as well as rope length, lubrication, and tension. Replace, lubricate, or adjust the rope as required.

Check the clearances for governor tension sheave, counterweight-to-buffer (with car at top landing), and compensation sheave to pit. Check governor sheave fastenings.

Check all of the timers in the system and reset if necessary.

Inspect guide rails, cams, fastenings, and counterweights in hoistways.

Test all of the terminal limit switches. Lubricate the limit switch roller pins.

Inspect the sheaves to verify that they are tight on the shafts, and sound their spokes and hubs with a hammer to inspect for cracks. Repair as necessary.

Lubricate the guide shoe stems.

PERFORMED ON AN ANNUAL BASIS:

Conduct Category 1 tests (and Category 5 tests, if due)

Brakes: Remove, clean, and lubricate the brake cores.
Inspect the brake linings for wear - clean or replace if necessary.
Adjust the brakes to wear evenly if necessary.

Motors: Inspect the armatures of hoist motor and motor-generator (if equipped).

Check the electrical connections.

Drain, flush, and refill the oil reservoirs.

Check the brushes for neutral settings and for proper quartering and spacing on the commutators. Reset if necessary.

Lubricate the bearings.

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Vacuum the carbon and dust.

Clean the screens.

Clean the guide rails with solvent to remove dirt, debris, or excess lubricant.

Drain, flush, and refill the gearing lubricant.

Test the car emergency light for required illumination.

Test and adjust dispatching, scheduling, and emergency service of the group supervisory control system (if equipped).

Check the compensation rope tension.

Lubricate the sheave bearings and check for leaky seals.

Clean the hoistway.

Vacuum the dust from controllers and relays.

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**Appendix C
MINIMUM PREVENTIVE MAINTENANCE
REQUIREMENTS FOR HYDRAULIC ELEVATORS**

The following items (as applicable) shall be included requirements of a maintenance contract.

(Note: When items are inspected and found to be defective, broken, out of adjustment, etc., they must be repaired, replaced, or adjusted to meet the requirements of the Code.)

PERFORMED ON A WEEKLY BASIS:

Inspect and lubricate (as required) the machinery, pumps, piping, drive, valves, selector, and controller.

Ride in the car and observe operation of doors, leveling, smoothness, and door reopening devices at each landing. Listen for unusual noises in the car and in the hoistway. If excessive creeping is occurring, determine cause and correct.

Check all car operating controls, lamps, and gongs. Replace burned-out lamps.

Clean:

- Drip pans (check oil levels of associated equipment)
- Door reopening device photo eye components
- Door tracks and sills
- Lamps and sensors in the car top controller
- Car top
- Machine room
- Pit
- Controller
- Selector
- Relay connectors
- Contacts

Inspect plunger seals and correct excess leakage.

PERFORMED ON A MONTHLY BASIS:

Check and adjust the car door operation. Lubricate the hangers, rollers, gibs, linkages, and pivot points. Check and adjust door clearances, eccentrics, arm bearings, speed control switches, cables, clutches, chains, and belts. Tighten the door drive system points.

Check the car telephone and alarm operations. Repair the alarm system if required.

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Check the operation of limit and safety switches in hoistway and in/on the car.

Test mechanism - Observe for proper operation of motor and pump, oil lines, tank, controls, plunger, packing, etc. Check the oil tank level. Check the packing of valves and cylinder for leakage and tighten if necessary.

Check the car emergency light.

Check the car ventilation system and heater.

Initiate the Phase I firefighter recall service and check for proper operation to a minimum of two floors under Phase II service.

PERFORMED ON A QUARTERLY BASIS:

Check the car for proper leveling operation. Adjust if required.

Check and clean the door switch contacts.

Check the door speed control switches.

Check the condition of resistors and mounting assemblies.

Check the car top and hoistway for loose covers, vanes, or components.

Inspect the traveling cables for damage.

Inspect the counterweight rope for wear and lubrication (if equipped).

Clean the governor rope (if equipped).

Inspect the rope hitches, fastenings, and shackles (if equipped).

PERFORMED ON A SEMI-ANNUAL BASIS:

Comprehensive inspection - see *Section 3.2* of this document.

PERFORMED ON AN ANNUAL BASIS:

Conduct Category 1 tests (and Category 3 and 5 tests, if due). Inspect the condition of the flexible hoses and replace as needed. Pressure hoses are required to be tested, inspected, and replaced according to the Code.

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Test a sample of the hydraulic fluid for viscosity, color, contamination, foaming, and other pertinent properties specified by the equipment manufacturer. Drain and replace the fluid if the tests show it does not meet the requirements of the equipment manufacturer.

Clean the guide rails with solvent.

Test the car emergency light for required illumination.

Clean the hoistway.

Vacuum the dust from controllers and relays.

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Appendix D
TYPICAL GUIDELINES FOR FULL SERVICE *
MAINTENANCE AGREEMENT FOR ELEVATORS

*Service agreements are typically either "full service" type or "examination and lubrication service" type:

Full service type - Contractor is compensated for accepting complete responsibility for the maintenance and operation of the elevator

Examination/lubrication service type - Contractor is compensated for performing minor adjustment, lubrication, and inspection of the elevator, but is not compensated for repairs and major adjustments. Repairs and major adjustments are performed by Reclamation, a separate Contractor, or by the Contractor—compensated for on a case-by-case basis.

A *full service* maintenance agreement shall have the following standard items (as applicable) included:

1. Description of elevator(s), including:
 - Location of elevator(s)
 - Type (geared, gearless, hydraulic, etc.)
 - Number of elevators
 - Capacity (pounds)
 - Speed (feet per minute)
 - Travel (feet)
 - Number of stops and openings
 - Service (freight, passenger, etc.)
 - Manufacturer
 - Serial number

2. Term of service of the agreement, including:
 - Dates and duration that the service agreement is effective.

 - Provision for either party to terminate the agreement at the end of the first 1, 2, or 5 years, or any subsequent 1-, 2-, or 5-year period, by giving 60 or 90 days' prior written notice.

 - An automatic contract extension may be included as part of the agreement.

3. Hours of Service:
 - Normal work performed during regular working hours of regular working days (unless otherwise specified).

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- Emergency callback available on a 24-hours-per-day, 7-days-per-week basis. Contractor to be paid overtime premium if work is performed outside normal work hours.
4. Service technician requirements:
- Work will be performed by trained and qualified personnel, directly employed and supervised by the Service Contractor.
 - Personnel will be required to be neat and perform work in a professional manner with minimal disruption to the availability of the elevator.
 - Personnel will be required to obey Reclamation regulations and allow Reclamation at all times to examine materials and equipment used by the Contractor and to observe at all times the operations of the Contractor at the work site.
5. Scope of work:
- The Contractor is required to perform preventive maintenance and emergency repair to keep the equipment properly adjusted and in safe operating condition by:
 - Regularly and systematically inspecting, adjusting, cleaning, lubricating, testing, repairing (if required), or replacing (if required) the equipment, including, but not limited to:
 - Machine - gears, worms, bearings, brakes, motor, motor brushes, motor windings (field and armature), commutators, rotating elements, coils, contacts, resistors, magnet frames.
 - Controller - contacts, resistors, Central Processing Unit (CPU), solid-state components
 - Selector - relay printed circuit boards, Silicon Controlled Rectifier (SCR) controls, condensers, transformers, contacts, leads, timers.
 - Traveling cable.
 - Main line disconnect.
 - Emergency lighting.
 - Governor - sheave assembly, governor rope tension sheave assembly, bearings, contacts, jaws.
 - Safeties - car, counterweight.

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- Sheaves - deflector, car top, secondary, compensation, etc. - bearings, shafts.
 - Ropes - hoisting, compensation (may be chains), governor equalize hoisting ropes tension
 - Buffers - car and counterweight, including switches, seals, and packing.
 - Guides - car and counterweight rails, rail clips, guide shoes/rollers. Renew guide shoe gibs or guide rollers as required for smooth and quiet operation. Perform rail alignment, adjust rail fasteners, determine rail condition.
 - Car - frame, platform, flooring, cab enclosure, fans, heaters, lighting, handrailing, load weighing devices, top of car.
 - Fixtures - position indicators, operating panels, hall call stations, car/hall lanterns and chimes.
 - Hoistway - lighting, limit switches, vanes.
 - Door equipment - operators, clutches, interlocks, hangers, safety edges, electric eyes, rollers, astragals, auxiliary door-closing devices.
 - Hydraulic machinery (if applicable) - motor, pump, control valve, strainers, mufflers, gaskets, seals, packing, jack unit, piping, hoses, fittings, dampers, silencers, and hydraulic fluid. Note that the condition of the hydraulic jack unit will have to be determined and a replacement schedule may be required in the contract.
- Maintaining a work log that lists required maintenance actions, time intervals, and notations indicating the work done. Locate the log in the machine room, where it can be accessed by Reclamation.
- The Contractor is responsible for maintaining the elevator as required by the wear and tear of normal elevator usage.
 - The Contractor shall furnish all parts, tools, equipment, lubricants, and cleaning supplies required for the work.
 - Reclamation shall include a schedule of items that the Contractor is not responsible for maintaining. Typical items that may fall under this category may include: removable panels, door panels, light diffusers, hung ceilings, handrails, mirrors, music systems, telephones, heaters, fans, air conditioners, ladders,

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support beams, flooring, frames, sills, door frames, cover plates, main line power disconnect, controller breakers and feeders, emergency power supply, batteries, and fire and smoke detectors.

- Reclamation shall include a schedule and method for payment of prorated items that are currently worn and will need to be replaced in the future.

6. Performance of elevator:

- The Contractor is required to maintain the operating speed, load capacity, landing requirements, and door opening and closing times.

7. Licenses, permits, insurance, and indemnification:

- The Contractor is responsible for obtaining and submitting all necessary licenses and standard operating permits.
- The Contractor is required to abide by all applicable codes, regulations, and standards.
- The Contractor must submit certificates (and any changes thereafter) of insurance showing Contractor coverage for liability for bodily injury, workers' compensation, property damage, and an umbrella liability policy.
- The Contractor is required to indemnify Reclamation to the maximum extent allowed by law from claims or damages arising from work generated by the service agreement.

8. Miscellaneous:

- Reclamation shall define the terms of payment.
- Reclamation shall provide a mechanism for dispute resolution as an alternative to litigation.
- Reclamation shall include provisions for curing a breach of contract claim to ensure work is completed.
- Reclamation shall include designation of the official representatives and emergency contacts for Reclamation and the Contractor.
- Required shutdowns for repair or maintenance of the elevator shall be coordinated with and approved by Reclamation.

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**Appendix E
ELECTRIC ELEVATOR PERIODIC TEST CHARTS**

ONE-year periodic tests for A17.1d (2000) and earlier editions Category "ONE" for A17.1-2000 and later editions		
Test Type	Reference Rule A17.1d (2000) and earlier	Reference Section A17.1- 2000 and later
Safety	1002.2b	8.11.2.2.2
Governor	1002.2c	8.11.2.2.3
Standby (Emergency) Power	1002.2g	8.11.2.2.7
Firefighters Service	1002.2f	8.11.2.2.6
Final and Normal Stopping Devices	1002.2e	8.11.2.2.5
Door Closing Force	1002.2h	8.11.2.2.8
Broken Rope, Tape, or Chain Switch	1002.2i	8.11.2.2.9
Oil Buffer	1002.2a	8.11.2.2.1
Winding Drum Machine Slack Rope Device	1002.2d	8.11.2.2.4

FIVE-year periodic tests for A17.1d (2000) and earlier editions Category "FIVE" for A17.1-2000 and later editions		
Test Type	Reference Rule A17.1d (2000) and earlier	Reference Section A17.1- 2000 and later
Safety	1002.3a	8.11.2.3.1
Governor	1002.3b	8.11.2.3.2
Braking System	1002.3d	8.11.2.3.4

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FIVE-year periodic tests for A17.1d (2000) and earlier editions		
Category "FIVE" for A17.1-2000 and later editions		
Test Type	Reference Rule A17.1d (2000) and earlier	Reference Section A17.1-2000 and later
Emergency Terminal Speed-limiting Device	1002.3f	8.11.2.3.6
Emergency and Standby Power Operation	1002.3e	8.11.2.3.5
Power Opening of Doors	1002.3g	8.11.2.3.7
Leveling Zone and Leveling Speed	1002.3h	8.11.2.3.8
Inner Landing Zone (Static)	1002.3i	8.11.2.3.9
Oil Buffer	1002.3c	8.11.2.3.3
Emergency Stopping Distance	--	8.11.2.3.10
Traction Test	--	8.11.2.3.10 (a and b)

MANAGEMENT AND SAFE HANDLING PROCEDURES FOR SF₆ GAS

Appendix F
HYDRAULIC ELEVATOR PERIODIC TEST CHARTS

ONE-year periodic tests for A17.1d (2000) and earlier editions Category "ONE" for A17.1-2000 and later editions		
Test Type	Reference Rule A17.1d (2000) and earlier	Reference Section A17.1-2000 and later
Relief Valve Setting and System	1005.2a	8.11.3.2.1
Flexible Hose and Fitting	1005.2d	8.11.3.2.4
Hydraulic Cylinder Leak Test	1005.2b	8.11.3.2.2
Emergency Terminal Speed Limiting Device	1005.2c(8)	8.11.3.2.3(h) Terminal Speed Reducing Device
Standby or Emergency Power Operation	1005.2c(6) [1002.2g]	8.11.3.2.3(f) [8.11.2.2.7]
Power Operation of Doors	1005.2c(7) [1002.2h]	8.11.3.2.3(g) [8.11.2.2.8]
Normal Terminal Stopping Devices	1005.2c(1) [1002.2e]	8.11.3.2.3(a) [8.11.2.2.5]
Slack Rope Device	1005.2f	8.11.3.1.3(z)
Firefighters Service	1005.2c(5) [1002.2f]	8.11.3.2.3(e) [8.11.2.2.6]
Pressure Switch	1005.2e	8.11.3.2.5
Oil Buffer (where provided)	1005.2c(4) [1002.2a]	8.11.3.2.3(d) [8.11.2.2.1]
Safety (where provided)	1005.2c(3) [1002.2b]	8.11.3.2.3(c) [8.11.2.2.2]
Governor (where provided)	1005.2c(2) [1002.2c]	8.11.3.2.3(b) [8.11.2.2.3]
Low Oil Protection Test	--	A17.1b-2003 8.11.3.2.3i

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THREE-year periodic tests for A17.1d (2000) and earlier editions		
Category "THREE" for A17.1-2000 and later editions		
Test Type	Reference Rule A17.1d (2000) and earlier	Reference Section A17.1-2000 and later
Piston Rods	1005.3a	8.11.3.3.1
Pressure Vessels	1005.3b	8.11.3.3.2

FIVE-year periodic tests for A17.1d (2000) and earlier editions		
Category "FIVE" for A17.1-2000 and later editions		
Test Type	Reference Rule A17.1d (2000) and earlier	Reference Section A17.1-2000 and later
Safety (where provided)	1005.4(a)	8.11.3.4.1 [8.11.2.3.1]
Governor (where provided)	1005.4(a)	8.11.3.4.1 [8.11.2.3.2]
Oil Buffer (where provided)	1005.4(a)	8.11.3.4.1 [8.11.2.3.3]
Overspeed Valve	--	8.11.3.4.4
Coated Ropes	1005.4(b)	8.11.3.4.2
Rope Fastening on Pistons	1005.4(c)	8.11.3.4.3

MISSION STATEMENTS

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.



The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.