BUREAU OF RECLAMATION

Facilities Instructions, Standards, and Techniques - Volume 2-10

Maintenance, Inspection, and Testing of Electric and Hydraulic Elevators

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Maintenance, Inspection, and Testing of Electric and Hydraulic Elevators

Prepared by

Power Resources Office
and
Technical Service Center

U.S. Department of the Interior
Bureau of Reclamation
Power Resources Office
Denver, Colorado

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Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; honors its trust responsibilities or special commitments to American Indians, Alaska Natives, Native Hawaiians, and affiliated 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.

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Elevator Maintenance Manual, by Zack McCain. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36606
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Hydraulic Elevator and Escalator Maintenance Log. Published by Elevator World, Inc., 356 Morgan Avenue, Mobile, Alabama 36660.
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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

Reclamation Standards and Documents

FAC 01-04	*Review of Operation and Maintenance Program Examination of Associated Facilities (Facilities Other Than High- and Significant-Hazard Potential Dams)*
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POMs: https://teamssp.bor.doi.net/printanddup/forms/POM%20Forms/Forms/AllItems.aspx
POM-226, FIST Revision Request
POM-300, FIST Variance Form

Acronyms and Abbreviations

ac	Alternating current
ADAAG	Americans with Disabilities Act – Accessibility Guidelines
ASME	American Society of Mechanical Engineers
dc	Direct current
FIST	Facilities Instructions, Standards, and Techniques
oz	Ounce
O&M	Operations and maintenance
PRO&M	Power Review Operations and Maintenance
PRO	Power Resources Office
Reclamation	Bureau of Reclamation
RSHS	Reclamation Safety and Health Standards
TSC	Technical Service Center
QEI	Qualified Elevator Inspector

Symbols

%	percent
~	approximately

1.0 Introduction

The Bureau of Reclamation operates and maintains hydroelectric powerplants, switchyards, pumping plants, water delivery equipment and associated facilities in the 17 western United States. These facilities house complex electrical and mechanical equipment that must be kept operational because they are critical to the electric power and water delivery systems relied on by many. FIST are technical documents that provide criteria and procedures that should be utilized by the offices involved in managing Reclamation facilities and assets.

This document establishes standard technical practices to ensure the safe, reliable, economic, and efficient operations and maintenance (O&M) of Federal facilities by keeping related assets in good condition and ultimately protecting Federal investments. These technical practices provide a sufficient level of detail to ensure consistent application while providing flexibility for the use of innovative techniques and approaches. This document was developed with input from staff in Reclamation's Denver, regional, and area offices.

There are over 125 elevators at various Reclamation pumping plants, powerplants, dams, office buildings, tunnels, and visitor facilities. The safety of these elevators is an ongoing concern of Reclamation. When properly maintained, inspected, and tested, elevators are an extremely safe and reliable means of vertical transportation. A malfunctioning elevator system potentially may cause loss of life or serious injury, or strand personnel in an elevator car. Many of the elevator systems at Reclamation facilities are aging and may not have a reliable record of inspection and maintenance. Additionally, many of these elevators may lack the safety features that are required by code to build an elevator today.

1.1 Purpose and Scope

This document is intended to promote uniformity in the manner that assets are managed, documented, and coordinated, and may be utilized by transferred facilities and other entities as appropriate. It establishes consistent procedures, minimum standards, and O&M criteria for hydroelectric equipment and systems owned and operated by Reclamation. Other technical documents may provide additional electrical and mechanical maintenance information for the equipment or systems discussed in this document.

O&M requirements are based on industry standards and experience. Maintenance requirements vary based on equipment condition and past performance, and sound engineering practices and maintenance management should be employed for special circumstances. Manufacturer recommendations and instructions should be consulted for additional maintenance that may be required beyond what is stated in this manual.

This volume includes standards, practices, procedures, and advice on day-to-day operation, maintenance, and testing of mechanical equipment in Reclamation facilities.

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 by Contractors and

In-house government maintenance programs. Much of the information contained in this document was obtained from the ASME codes and related publications. These codes are further discussed in section 2.0.

The scope of this documents is to provide maintenance guidance and reference to required inspections and testing of elevators. An overview of elevator modernization and basic service contracts are discussed to bring awareness to facility staff and highlight concerns or best practices that could be helpful in the development of contractual documents.

1.2 Reclamation Standard Practices

FIST manuals are designed to provide guidance for maintenance and testing on equipment in Reclamation's facilities. There may be multiple ways to accomplish tasks outlined in this document. Facilities may exercise discretion as to how to accomplish certain tasks based on equipment configurations and available resources.

Reclamation's regions, Power Resources Office (PRO), and Technical Service Center (TSC) agree that certain practices are required to be consistent across all Reclamation facilities. Mandatory FIST procedures, practices, and schedules that appear in **{Red, bold, and bracketed}** or **[Black, bold, and bracketed]** text are considered Reclamation requirements for the O&M of equipment in power facilities. RM D&S FAC 04-14, *Power Facilities Technical Documents*, describes the responsibilities required by text designations: **{Red, bold, and bracketed}**, **[Black, bold, and bracketed]**, and plain text, within this technical document.

Refer to RM D&S FAC 04-14 for more details concerning technical documents.

1.3 Maintenance Tables

Maintenance tables for tasks described in this document are included in FIST 4-1B, *Maintenance Scheduling for Electrical Equipment*.

1.4 Manufacturer Recommendations

The information in this document is based on manufacturers' documentation and historic Reclamation practices. Due to the differences in equipment designs, owner's manuals and manufacturer's recommended maintenance should be consulted when developing job plans. Not following the manufacturer's guidance may void the warranty of new equipment. If there is a discrepancy between the FIST and the manufacturer's recommendations, the job plan must use the more stringent practice unless there is a reason that a less restrictive maintenance practice is warranted. Use of a less restrictive maintenance practice must be approved as outlined in RM D&S FAC 04-14 by either a deviation or a variance. A deviation maybe granted in accordance with RCD 03-03 and POM Form 300.

1.5 FIST Revision Requests

The FIST Revision Request Form (POM-226) is used to request changes to a FIST document. The request will include a summary of the recommended changes and a basis for the revision or new FIST. These forms will be submitted to the Manager, PRO. The PRO Manager will keep a list of Revision Requests for each FIST and include these in the next scheduled revision unless the change is prioritized sooner.

1.6 Mechanical Database

The TSC Mechanical Equipment Group created and maintains a Mechanical Equipment Database. All Reclamation employees have access to the database, which contains test data, operating data, and general information about the following:

1) Turbines
2) Governors
3) Gates and valves
4) Pressure vessels
5) Penstocks
6) Elevators
7) Hoists
8) Cranes

The database:

1) Provides visibility of other Reclamation facilities with similar equipment; i.e., find all Reclamation facilities with Obermeyer Gates.
2) Is a critical tool for facility reviewers, i.e., reviewers can obtain printable forms from the database website for each asset being reviewed. The form can be taken to the site and used to compare and update information.
3) Tracks equipment testing frequencies and critical data comparison. For example, governor alignment results can be compared to the previous governor alignment results. An increase in operating pressures or opening/closing times can indicate gate repairs are required.
4) Provides updated testing and inspection dates for gates, valves, pressure vessels, and penstocks for mechanical inspectors/reviewers to use during Power Reviews (RM D&S FAC 04-01), Associated Facilities Reviews (RM D&S FAC 01-04), and High and Significant Hazard Dam Reviews (RM D&S FAC 01-07).

When tests and alignments, as outlined in FIST 4-1B, *Maintenance Scheduling for Electrical Equipment* or the database, are completed, facilities or regional personnel should submit the recorded data to the Mechanical Equipment Group (bordromechequipdb@usbr.gov). A service agreement is established with TSC to update the database and keep it accurate. The PRO&M review programs use this database to ensure tests and alignment are up to date and are being tracked.

The link to the Mechanical Equipment Database is: https://mechdb.usbr.gov/MechDB/.

2.0 Resources

The ASME Elevator Codes and publications that are pertinent to the inspection and maintenance of Reclamation elevators are indicated below.

Most of the documents below may be accessed and downloaded using the following Reclamation resource: https://intra.usbr.gov/tsc/techreferences/industrystandards-non_rec/IHSsubscription.html

If necessary, the most recent version of elevator codes can be purchased from the ASME website (https://www.asme.org/).

2.1 Elevator Codes

2.1.1 ASME A17.1/CSA B44 (previously designated as ASME A17.1) – "Safety Code for Elevators and Escalators"

This code covers installation requirements for new elevators, as well as maintenance and test requirements for existing equipment.

2.1.2 ASME A17.2 – "Inspectors' Manual for Elevators and Escalators"

This code is a guide that provides recommended procedures for inspection and testing of equipment to comply with A17.1/CSA B44 and A17.3.

2.1.3 ASME A17.3 – "Safety Code for Existing Elevators and Escalators"

This code 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/CSA B44 requirements.

2.1.4 ASME A17.4 – "Guide for Emergency Evacuation of Passengers from Elevators"

This code establishes procedures for the safe evacuation of passengers from stalled elevators.

2.1.5 ASME A17.1 – "Handbook and ASME A17.1 Interpretations"

These codes provide assistance for understanding and gaining insight into the Code requirements and rules.

2.1.6 ASME QEI-1

This code establishes the requirements for the qualification, duties, and responsibilities of inspectors and inspection supervisors engaged in inspection and testing.

2.2 Usage of Elevator Codes

The Code requires that maintenance, repair, inspections, tests, and replacements only need to conform to the Code in effect 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 editions to the Code are issued approximately every 3 years, along with intermediate supplements, which are issued as needed. The terms Alteration, Maintenance, Repair, and Replacement are specific terms defined by the Code and are included in Appendix A for reference. These terms are important and should be understood when using this document.

3.0 Description

3.1 General Description

An elevator is a hoisting mechanism which moves a car within guides to two or more landings. There are many different types of elevators which fall into two main categories: electric and hydraulic.

3.1.1 Electric Elevator

An electric elevator uses an electric driving machine to move the car up and down the hoistway. In most applications, this drive machine converts electrical energy to rotational energy. Through a series of sheaves and wire ropes this rotational energy is converted to vertical travel of the car. To assist the drive machine, a counterweight can be installed which will travel in the opposite direction of the car. Electric elevators can be used in a variety of applications, capacities, speeds, and travels.

3.1.2 Hydraulic Elevator

A hydraulic elevator uses pressurized fluid in a hydraulic jack to move the car up and down the hoistway. In most applications, electric energy is used to operate a system of pumps which push fluid into a hydraulic jack which is connected to the bottom of the car. Hydraulic elevators are much more limited in their applications. Most hydraulic elevators are used for high capacity, low speed, and short travel applications.

4.0 Maintenance Program

This section discusses the general requirements for the maintenance program, as well as maintenance and inspection tasks and procedures. Testing is also a critical element to the maintenance program and will be discussed.

4.1 General

A strong preventive maintenance program, combined with scheduled inspections and testing, will help 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. Any subjective decisions should be noted and logged to provide continuity and background for responsible personnel.

All maintenance, repairs, replacements, and alterations must conform to the applicable section(s) of the Code. A code data plate is provided on each unit; this indicates the Code edition in effect at the time of installation and the current Code edition at the time of any alteration. The plate should 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.

At no time, except when necessary during tests and inspections, may required safety devices or electrical protection devices be made ineffective. In the event these devices are made temporarily ineffective, they must be returned to full operating condition before the elevator can be returned to service.

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.

4.1.1 Maintenance Personnel

In accordance with the Code, maintenance, repairs, replacements, and tests are to be performed only by qualified persons trained to perform these operations on the equipment. Training of personnel should be certified as adequate by the Facility Manager, prior to performance of work.

Maintenance personnel are not required to be Qualified Elevator Inspectors (QEI) as defined by ASME QEI-1. It is best practice to have separate personnel perform and check work.

4.1.2 Maintenance Records

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 on file.

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

4.1.3 Repairs

Repair parts shall be the equivalent material, strength, and design as originally intended.

Whenever repairs are made, maintenance personnel should reference the code to determine any specific requirements and testing associated with the component.

4.1.4 Replacements

Replacement parts shall be the equivalent material, strength, and design as originally intended.

Whenever replacements are made, maintenance personnel should reference the code to determine any specific requirements and testing associated with the component.

Replacement of the speed governor is considered an alteration. For additional information about alterations see section 5.0.

4.2 Maintenance Tasks

A maintenance task is what needs to be accomplished. The procedure is the instruction on how to accomplish a specific task. Section 1.3 contains information on where to find the frequency to which these tasks are performed. Often, specific maintenance instructions will be included in equipment manuals.

When cleaning electrical equipment it is important to use Electrostatic Discharge (ESD) safe or antistatic devices so as not to damage the equipment.

Where applicable, the below tasks are to be included in facility periodic maintenance job plans.

4.2.1 Electrical Elevators

4.2.1.1 Visual Inspection

Visually inspect machinery, sheaves, worm gear, motor, brake, selector, and controller for signs of obvious damage. Lubricate as required.

4.2.1.2 Operational Inspection

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.

4.2.1.3 General Housekeeping

Clean the machine room, pit, elevator car, and other elevator areas. Empty drip pans.

4.2.1.4 Machine Brake

Check operation of the machine brake for the following:

1) Verify that each time the elevator stops, the brake sets without delay.
2) Unusual smell indicating overheating or burning.
3) Brake linings. This can be checked with the motion of the brake. Normal brakes will compress less than $1/16^{th}$ inch.
4) Check for contaminants (oil, grease, etc.) on the brake drum lining.
5) Scoring or other damage to brake drum.
6) Evidence of tampering with brake spring tension or electrical switches.
7) Brake contacts are in the proper position.
8) Broken or damaged springs.
9) Heating of the brake drum. The drum should be cooler than the motor and gear.
10) Cracks in the drum and flanges.

4.2.1.5 Governor

Perform maintenance on the governor by doing the following:

1) Remove dirt and excess grease/lubricant from the rope-gripping jaws and sheave using a solvent and wiping cloth. A stiff nylon brush may be required for hard-to-reach places.
2) Insert lubricant in bearings where necessary, being sure to wipe clean any excess.

4.2.1.6 Car Doors

Examine the door operator for:

1) Loose or missing parts/fasteners.
2) Lubricate gear reducer and shaft bearings if necessary.
3) Tightness of belts.
4) Clean and lubricate drive chains if necessary. Clean excess lubrication off of chain.
5) Clean controls, cams, resistors, and other components of dust and debris.

Examine the door hangers, locks, etc. for:

1) The car doors cannot open without unlocking the interlock.
2) Unlock the door and open, verify the door closes by itself.
3) Open and close the hoistway door watching for any roughness in the travel and listening for any noise that would indicate dragging or binding.
4) If felt wicks are used to lubricate metal rollers, lubricate as necessary.
5) Examine sill guides for wear.

Examine vertical sliding doors and gates for:

1) Proper operation of mechanisms.
2) Clean dirt and debris from chains using a stiff nylon brush.
3) Lubricate equipment where necessary (motors, bearings, chains, etc.).
4) Wipe dirt and buildup from door gate tracks. If heavy buildup has occurred, use a putty knife and solvent.

4.2.1.7 Controller and Selector

Perform maintenance on the controller and selector by doing the following:

1) Using a plastic wand and nylon bristle brush, vacuum any dirt and dust. Always power off and lock out and tag out the elevator before cleaning.
2) Clean the selector tape and, if necessary, apply a light coat of oil. Some selectors do this automatically.
3) Check for burned contacts or worn brushes.
4) Check the fuses for proper class, rating, and position in holders.
5) Check the cooling fan and replace filters if necessary.
6) Visually inspect resistor tubes for loose bands and connections, cracks, and broken wires.

4.2.1.8 Car Telephone

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

4.2.1.9 Buffers

Perform maintenance on the car and counterweight buffers by doing the following:

1) Check the oil level in the car and in the counterweight oil buffers. Add oil as required.
2) Remove any rust and dirt on the plunger with a fine emery paper. Coat in a light coat of oil. Some plungers are coated in a preservative that should not be removed.
3) Measure the length of the plunger to verify it is fully extended. The stroke should be noted on the data plate.

4.2.1.10 Motor Brushes and Commutators

Perform maintenance on the brushes and commutators by doing the following:

1) Check the brushes for tension, seating, and wear (replace or adjust as required). The correct brush seating height should be determined by the manufacturer. This could be anywhere from $1/16^{th}$ to $1/8^{th}$ inch.
2) Check commutators for finish, grooving, eccentricity, and mica level – clean, turn, or refinish as required.
3) Make sure the environment is maintained in the range specified by the elevator equipment manufacturer. If a range has not been provided, maintain a ~40-60% relative humidity. This will ensure proper brush and commutator film and maximize brush life.
4) Remove dust on the brushes with a vacuum.
5) Change out worn brushes. Make sure to use the same type of brush from the same manufacturer.

4.2.1.11 Car Ventilation System and Heater

Check for proper operation of the car ventilation system and heater. If necessary, remove ventilation fan and clean the blades or squirrel cage. Lubricate components as necessary.

4.2.1.12 Car Top and Hoistway

Perform maintenance on the car top and hoistway by doing the following:

1) Verify correct operation of the top-of-car operating station.
2) Check car top and hoistway for loose covers, vanes, or components.
3) Clean debris and oil stains from top of car.
4) Verify top of car emergency exit is secure.

5) Examine the deflection sheave for fastening, rope tracking, and cleanliness.
6) Check the deflection sheave for cracks by lightly tapping with a small (2 oz) hammer. If the sound is a clear ring, there is no damage. If the ring is not clear, investigate further.
7) Clean excess lubricant that has extruded from the seals.
8) Take note of any piles of steel filings under the sheave. This could denote damage to the wire ropes or the sheave.
9) Examine the counterweight sheaves in the same manner.
10) Check slide guides (if applicable) for proper fastening to crosshead and fit on the rails. If the guide uses a wick to lubricate the rails, check the oil level. Refill with the indicated fluid type, if necessary.
11) Check roller guides (if applicable) for the condition of the tires and proper fit on the rails. The wheels should contact the rail with force but be able to be turned by hand with a good amount of force. Check that the plane of the center tire is square with the face of the rail. Lubricate the pivot bushing as needed.
12) Examine the guides for loose hardware. Clean the rail of dirt and debris.

4.2.1.13 Traveling Cables

Inspect the traveling cables for:

1) Wear, chafing, chinking, and alignment. Chafing will be common at beams, bolts, rough walls, and other items that could contact the traveling cable.
2) Examine the attachment points for secure fastenings.
3) Check that all mesh grip hangers are fully supporting the cable.

4.2.1.14 Wire Ropes and Fastenings

Inspect the suspension and compensating rope and fastenings for:

1) Secure fastenings.
2) Equalizer springs (if used) for position and brakes.
3) A means to prevent rotation of the ropes.
4) Damage to the wire rope (broken strands, loss of rope lay, reduced diameter etc.).
5) Adequate lubrication. Check that these are not contaminated with dust or debris.
6) Equal tension between all ropes in each set. This can be done by measuring the deflection of the wire rope when equal force is applied laterally. There are special devices made to quantify this value.
7) Inspect the rope sockets for the following:
    a. Embedment material must be visible at small end where rope emerges and must fill the socket to the brim.
    b. The strand bends are distributed equally around the large end of the socket.
    c. No loss of rope lay where the rope emerges from the socket.

CAUTION: Do not lubricate the governor wire rope. Code prohibits lubrication after installation. Over-lubrication could lead to the failure of the governor to activate the safety and arrest an over speeding car.

Inspect the governor rope for:

1) Secure fastenings at the safety attachment point or the release carrier.
2) Damaged wire rope (broken strands, reduced diameter, loss of lay, etc.).
3) Dust, oil, or grease contamination. The governor wire ropes should not be lubricated.

Inspect the compensating rope for:

1) Verify the rope does not touch the ground at any point.
2) Clean rope of dust of debris contamination.
3) Lubricate the sheave bearing, if necessary.
4) Check the oil level on the compensating rope sheave oil cylinder, if applicable. Fill if necessary.

4.2.1.15 Sheaves

Inspect the drive sheave for:

1) Verify all ropes seat to the same depth. Lay a straight edge over the crown of the ropes, across the sheave, and check if all ropes are even with the edge.
2) If the groove shape is NOT "U" groove, verify that the ropes do not contact the bottom of the groove.
3) Check for excess lubricant which has led to dirt and build-up in the grooves. Clean where necessary. Wiping a finger on a groove should yield only a light trace of oil. If there is a heavy smudge, the wire ropes and sheaves need cleaning.
4) Check for sings of "rope imprints" in the groove surface. Excess lubricant and buildup may cause the groove to appear as though there are rope imprints. Properly clean sheaves prior to checking for rope imprint.

Inspect the deflection sheave for:

1) Verify all ropes seat to the same depth. Lay a straight edge over the crown of the ropes, across the sheave, and check if all ropes are even with the edge.
2) Use a sheave groove gauge to measure the sheave wear. Verify grooves are within acceptable limits.
3) Check for excess lubricant which has led to dirt and build-up in the grooves. Clean where necessary. Wiping a finger on a groove should yield only a light trace of oil. If there is a heavy smudge, the wire ropes and sheaves need cleaning.
4) Verify all fastenings are secure.
5) Check for signs of bearing failure or misalignment. When traveling the elevator, if the deflection sheave makes excess noise or there is wobble, these could be signs of bearing failure.
6) Check for sings of "rope imprints" in the groove surface. Excess lubricant and buildup may cause the groove to appear as though there are rope imprints. Properly clean sheaves prior to checking for rope imprint.

Inspect the compensation sheave for:

1) Verify all ropes seat to the same depth. Lay a straight edge over the crown of the ropes, across the sheave, and check if all ropes are even with the edge.
2) Use a sheave groove gauge to measure the sheave wear. Verify grooves are within acceptable limits.
3) Check for excess lubricant which has led to dirt and build-up in the grooves. Clean where necessary. Wiping a finger on a groove should yield only a light trace of oil. If there is a heavy smudge, the wire ropes and sheaves need cleaning.
4) Verify all fastenings are secure.
5) Check for signs of bearing failure or misalignment. When traveling the elevator, if the deflection sheave makes excess noise or there is wobble, these could be signs of bearing failure.
6) Verify that the sheave is free to move vertically. Physically move the sheave up and down or visually verify movement when traveling elevator car.

4.2.1.16 Safeties

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

4.2.2 Hydraulic Elevators

4.2.2.1 Visual Inspection

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

4.2.2.2 Operational Inspection

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.

4.2.2.3 General Housekeeping

Clean the machine room, pit, elevator car, and other elevator areas. Empty drip pans.

4.2.2.4 Plunger Seals

Inspect plunger seals and correct excess leakage.

4.2.2.5 Governor

Perform maintenance on the governor by doing the following:

1) Remove dirt and excess grease/lubricant from the rope gripping jaws and sheave using a solvent and wiping cloth. A stiff nylon brush may be required for hard-to-reach places.
2) Insert lubricant in bearings where necessary, being sure to wipe clean any excess.

4.2.2.6 Car Doors

Examine the door operator for:

1) Loose or missing parts/fasteners.

2) Lubricate gear reducer and shaft bearings if necessary.
3) Tightness of belts.
4) Clean and lubricate drive chains if necessary. Clean excess lubrication off of chain.
5) Clean controls, cams, resistors, and other components of dust and debris.

Examine the door hangers, locks, etc. for:
1) The car doors cannot open without unlocking the interlock.
2) Unlock the door and open, verify the door closes by itself.
3) Open and close the hoistway door, watching for any roughness in the travel and listen for any noise that would indicate dragging or binding.
4) If felt wicks are used to lubricate metal rollers, lubricate as necessary.
5) Examine sill guides for wear.

For vertical sliding doors and gates, examine for:
1) Proper operation of mechanisms.
2) Clean dirt and debris from chains using a stiff nylon brush.
3) Lubricate equipment where necessary (motors, bearings, chains, etc.).
4) Wipe dirt and buildup from door gate tracks. If heavy buildup has occurred, use a putty knife and solvent.

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

4.2.2.8 Buffers
Perform maintenance on the car and counterweight buffers by doing the following:
1) Check the oil level in the car and in the counterweight oil buffers. Add oil as required.
2) Remove any rust and dirt on the plunger with a fine emery paper. Coat in a light coat of oil. Some plungers are coated in a preservative that should not be removed.
3) Measure the length of the plunger to verify it is fully extended. The stroke should be noted on the data plate.

4.2.2.9 Plunger and Cylinder
Examine the plunger for proper attachment to the car frame, damage or roughness on the surface, and a tight fit between the plunger sections.

Examine the cylinder for visible leaks and if a leak detection means is used, check for other leaks.

4.2.2.10 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.

4.2.2.11 Car Ventilation System and Heater
Check for proper operation of the car ventilation system and heater. If necessary, remove ventilation fan and clean the blades or squirrel cage. Lubricate components as necessary.

4.2.2.12 Car Top and Hoistway

Perform maintenance on the car top and hoistway by doing the following:

1) Verify correct operation of the top-of-car operating station.
2) Check car top and hoistway for loose covers, vanes, or components.
3) Clean debris and oil stains from top of car.
4) Verify top of car emergency exit is secure.
5) Examine the sheave, if applicable, for fastening, rope tracking, and cleanliness.
6) Check the sheave for cracks by lightly tapping with a small (2 oz) hammer. If the sound is a clear ring, there is no damage. If the ring is not clear, investigate further.
7) Clean excess lubricant that has extruded from the seals.
8) Take note of any piles of steel filings under the sheave. This could denote damage to the wire ropes or the sheave.
9) Check slide guides (if applicable) for proper fastening to crosshead and fit on the rails. If the guide uses a wick to lubricate the rails, check the oil level. Refill with the indicated fluid type, if necessary.
10) Check roller guides (if applicable) for the condition of the tires and proper fit on the rails. The wheels should contact the rail with force but be able to be turned by hand with a good amount of force. Check that the plane of the center tire is square with the face of the rail. Lubricate the pivot bushing as needed.
11) Examine the guides for loose hardware. Clean the rail of dirt and debris.

4.2.2.13 Traveling Cables

Inspect the traveling cables for:

1) Wear, chafing, chinking, and alignment. Chafing will be common at beams, bolts, rough walls, and other items that could contact the traveling cable.
2) Examine the attachment points for secure fastenings.
3) Check that all mesh grips hangers are fully supporting the cable.

4.2.2.14 Wire Ropes and Fastenings

Inspect the counterweight rope (if applicable) for:

1) Secure fastenings.
2) Damage to the wire rope (broken strands, loss of rope lay, reduced diameter etc.).
3) Proper lubrication. Clean the ropes of any dirt or debris.
4) Equal tension on each rope. This can be done by measuring the deflection of the wire rope when equal force is applied laterally. There are special devices made to quantify this value.
5) Inspect the rope sockets for the following:
    a. Embedment material must be visible at small end where rope emerges and must fill the socket to the brim.
    b. The strand bends are distributed equally around the large end of the socket.
    c. No loss of rope lay where the rope emerges from the socket.

CAUTION: Do not lubricate the governor wire rope. Code prohibits lubrication after installation. Over-lubrication could lead to the failure of the governor to activate the safety and arrest an over speeding car.

Inspect the governor rope for:

1) Secure fastenings at the safety attachment point or the release carrier.
2) Damaged wire rope (broken strands, reduced diameter, loss of lay, etc.).
3) Dust, oil, or grease contamination. The governor wire ropes should not be lubricated.

Inspect the compensating rope (if applicable) for:

1) Verify the rope does not touch the ground at any point.
2) Clean rope of dust of debris contamination.
3) Lubricate the sheave bearing, if necessary.
4) Check the oil level on the compensating rope sheave oil cylinder, if applicable. Fill if necessary.

4.2.2.15 Sheaves (if applicable)

Inspect counterweight sheave for:

1) Verify all ropes seat to the same depth. Lay a straight edge over the crown of the ropes, across the sheave, and check if all ropes are even with the edge.
2) Use a sheave groove gauge to measure the sheave wear. Verify grooves are within acceptable limits.
3) Check for excess lubricant which has led to dirt and build-up in the grooves. Clean where necessary. Wiping a finger on a groove should yield only a light trace of oil. If there is a heavy smudge, the wire ropes and sheaves need cleaning.
4) Verify all fastenings are secure.
5) Check for signs of bearing failure or misalignment. When traveling the elevator, if the deflection sheave makes excess noise or there is wobble, these could be signs of bearing failure.
6) Check for sings of "rope imprints" in the groove surface. Excess lubricant and buildup may cause the groove to appear as though there are rope imprints. Properly clean sheaves prior to checking for rope imprint.

Inspect the compensation sheave for:

1) Verify all ropes seat to the same depth. Lay a straight edge over the crown of the ropes, across the sheave, and check if all ropes are even with the edge.
2) Use a sheave groove gauge to measure the sheave wear. Verify grooves are within acceptable limits.
3) Check for excess lubricant which has led to dirt and build-up in the grooves. Clean where necessary. Wiping a finger on a groove should yield only a light trace of oil. If there is a heavy smudge, the wire ropes and sheaves need cleaning.
4) Verify all fastenings are secure.

5) Check for signs of bearing failure or misalignment. When traveling the elevator, if the deflection sheave makes excess noise or there is wobble, these could be signs of bearing failure.
6) Verify that the sheave is free to move vertically. Physically move the sheave up and down or visually verify movement when traveling elevator car.

4.3 Inspection

The Code requires periodic inspection of elevators completed by qualified elevator personnel and witnessed by a QEI. After testing, a report must be written and submitted by the QEI containing the date of the inspection, the type of tests performed, detail results of the tests, and any code deficiencies noted including a statement as to corrective action taken, if any.

4.3.1 Electrical Elevators

The following items are to be included when identifying components or systems to be inspected.

4.3.1.1 Inside the Car (ASME A17.1.8.11.2.1.1)

1) Door Reopening Device
2) Stop Switches
3) Operating Control Devices
4) Car Floor and Landing Sill
5) Car Lighting
6) Car Emergency Signal
7) Car Door or Gate
8) Door Closing Force
9) Power Closing of Doors or Gates
10) Power Opening of Doors or Gates
11) Car Vision Panels and Glass Car Doors
12) Car Enclosure
13) Emergency Exit
14) Ventilation
15) Signs and Operating Device Symbols
16) Rated Load, Platform Area, and Data Plate
17) Standby or Emergency Power Operation
18) Means to Restrict Hoistway or Car Doors Opening and Expiration Date for the Alternate Power Source
19) Car Ride
20) Door Monitoring Systems
21) Stopping Accuracy
22) Machinery Space/Control Space
23) Working Areas in the Car
    a. Means to prevent unexpected movement
    b. Unexpected car movement device
    c. Operating instructions for unexpected car movement
    d. Operating instructions for egress and reentry procedure
24) Equipment Access Panel Electrical Device

25) Earthquake Inspections and Tests

4.3.1.2 Machine Rooms, Machinery Spaces, and Control Rooms/Spaces (ASME A17.1.8.11.2.1.2)

1) Equipment Exposure to Weather
2) Means of Access
3) Headroom
4) Means Necessary for Tests
5) Inspection and Test Panel
6) Lighting and Receptacles
7) Enclosure of Machine Room, Machinery Spaces, and Control Room/Spaces
8) Housekeeping
9) Ventilation
10) Fire Extinguisher
11) Pipes, Wiring, and Ducts
12) Guarding of Equipment
13) Numbering of Elevators, Machines, and Disconnect Switches
14) Maintenance Path and Maintenance Clearance
15) Stop Switch
16) Disconnecting Means and Control
17) Controller Wiring, Fuses, Grounding, etc.
18) Static Control
19) Machinery Supports and Fastenings
20) Driving-Machine Brake
21) Traction-Drive Machines
22) Gears, Bearings, and Flexible Connections
23) Winding-Drum Machine
24) Belt- or Chain-Drive Machine
25) Motor Generator
26) Absorption of Regenerated Power
27) Traction Sheaves
28) Secondary and Deflector Sheaves
29) Rope Fastenings
30) Terminal Stopping Devices
31) Operating Devices
32) Governor, Overspeed Switch, and Seal
33) Car and Counterweight Safeties
34) Code Data Plate
35) Emergency Brake
36) AC Drives from a dc Source
37) Slack-Rope Devices
38) Wiring Diagrams
39) Rope Retainers or Restraints for Seismic Risk Zones
40) Seismic and Counterweight Displacement Detection Devices
41) The USI of the Installed Software matches the Onsite Documentation

4.3.1.3 Top of Car (ASME A17.1.8.11.2.1.3)

1) Top-of-Car Stop Switch
2) Car Top Light and Outlet
3) Top-of-Car Operating Device and Working Platforms
4) Top-of-Car Clearance and Refuge Space
5) Top Counterweight Clearance
6) Car, Overhead, and Deflector Sheaves
7) Normal Terminal Stopping Devices
8) Final Terminal Stopping Devices
9) Broken Rope, Chain, or Tape Switch
10) Car-Leveling Devices
11) Crosshead Data Plate
12) Top Emergency Exit
13) Counterweight and Counterweight Buffer
14) Counterweight Safeties
15) Floor and Emergency Identification Numbering
16) Hoistway Construction
17) Hoistway Smoke Control
18) Pipes, Wiring, and Ducts
19) Windows, Projections, Recesses, and Setbacks
20) Hoistway Clearance
21) Multiple Hoistways
22) Traveling Cables and Junction Boxes
23) Door and Gate Equipment
24) Car Frame and Stiles
25) Guide Rails Fastening and Equipment
26) Governor Rope
27) Governor Releasing Carrier
28) Fastenings and Hitch Plate
29) Suspension Means
30) Compensation Means
31) Machinery Space/Control Space
32) Working Areas on the Car Top
    a. Means to prevent unexpected movement
    b. Unexpected car movement device
    c. Operating instructions for unexpected car movement device
    d. Operating instructions for egress and reentry procedure
33) Equipment Exposure to Weather
34) Machinery Supports and Fastenings
35) Guarding of Exposed Auxiliary Equipment
36) Anchoring of Beams and Supports in Seismic Risk Zone 2 or Greater
37) Position Restraints in Seismic Risk Zone 2 or Greater
38) Car and Counterweight Guide-Rail System in Seismic Risk Zone 2 or Greater
39) For seismic risk zone 2 or greater, horizontal clearance for car and counterweight, snag-point clearance, and rail fastening
40) Seismic risk zone 2 or greater rope retainer and snag guard for compensating ropes or chains and compensating tension sheave fastening

41) Sheaves with nonmetallic groove surfaces

4.3.1.4 Outside of Hoistway (ASME A17.1.8.11.2.1.4)

1) Car Platform Guard
2) Hoistway Doors
3) Vision Panels
4) Hoistway Door Locking Devices
5) Access to Hoistway
6) Power Closing of Hoistway Doors
7) Sequence Operation
8) Hoistway Enclosure
9) Elevator Parking Devices
10) Emergency and Access Hoistway Openings
11) Separate Counterweight Hoistway
12) Standby Power Selection Switch
13) Means Necessary for Tests
14) Inspection and Test Panel, Inspection Operation, and Inspection Operating with Open Door Circuits
15) Equipment Exposure to Weather

4.3.1.5 Pit (ASME A17.1.8.11.2.1.5)

1) Pit Access, Lighting, Stop Switch, and Condition
2) Bottom Clearance and Runby
3) Car and Counterweight Buffer
4) Final Terminal Stopping Devices
5) Normal Terminal Stopping Devices
6) Traveling Cables
7) Governor-Rope Tensions Devices
8) Compensating Chains, Ropes, and Sheaves
9) Car Frame and Platform
10) Car Safeties and Guiding Members
11) Machinery Space/Control Space
12) Working Areas in the Pit
    a. Means to prevent unexpected movement
    b. Unexpected car movement device
    c. Operating instructions for unexpected car movement device
    d. Operating instructions for egress and reentry procedure
13) Equipment Exposure to Weather
14) Machinery Supports and Fastenings
15) Guarding of Exposed Auxiliary Equipment
16) Pit Inspection Operation

4.3.1.6 Firefighter's Emergency (ASME A17.1.8.11.2.1.6)

1) Check that the monthly operation log is maintained.

4.3.1.7 Working Platforms (ASME A17.1.8.11.2.1.7)

1) Working Platforms

   a. Operating Instructions
2) Retractable Stops
   a. Retractable Stop Electrical Device
3) Inspection Operation

4.3.1.8 Braking System (ASME A17.1.8.11.2.1.8)

1) Seal on Means of Adjusting the Holding Capacity of the Driving-Machine

4.3.2 Hydraulic Elevators

The following items are to be included when identifying components or systems to be inspected.

4.3.2.1 Inside the Car (ASME A17.1.8.11.3.1.1)

1) Door Reopening Device
2) Stop Switches
3) Operating Control Devices
4) Car Floor and Landing Sill
5) Car Lighting and Receptacles
6) Car Emergency Signal
7) Car Door or Gate
8) Door Closing Force
9) Power Closing of Doors or Gates
10) Power Opening of Doors or Gates
11) Car Vision Panels and Glass Car Doors
12) Car Enclosure
13) Emergency Exit
14) Ventilation
15) Signs and Operating Device Symbols
16) Rated Load, Platform Area, and Data Plate
17) Standby or Emergency Power Operation
18) Means to Restrict Hoistway or Car Doors Opening
19) Car Ride
20) Door Monitoring Systems
21) Stopping Accuracy
22) Machinery Space/Control Space
23) Working Areas in the Car
   a. Means to prevent unexpected movement
   b. Unexpected car movement device
   c. Operating instructions for unexpected car movement
   d. Operating instructions for egress and reentry procedure
24) Equipment Access Panel Electrical Device

4.3.2.2 Machine Rooms, Machinery Spaces, and Control Rooms/Spaces (ASME A17.1.8.11.3.1.2)

1) Equipment Exposure to Weather
2) Means of Access
3) Headroom
4) Means Necessary for Tests

5) Inspection and Test Panel
6) Lighting and Receptacles
7) Enclosure of Machine Room, Machinery Spaces, and Control Room/Spaces
8) Housekeeping
9) Ventilation and Heating
10) Fire Extinguisher
11) Pipes, Wiring, and Ducts
12) Guarding of Equipment
13) Numbering of Elevators, Machines, and Disconnect Switches
14) Maintenance Path and Maintenance Clearance
15) Stop Switch
16) Disconnecting Means and Control
17) Controller Wiring, Fuses, Grounding, etc.
18) Hydraulic Power Unit
19) Relief Valves
20) Control Valve
21) Tanks
22) Flexible Hydraulic Hose and Fitting Assemblies
23) Supply Line and Shutoff Valve
24) Hydraulic Cylinders and Hydraulic Fluid Loss Record
25) Pressure Switch
26) Recycling Operation
27) Code Data Plate
28) Governor, Overspeed Switch, and Seal
29) Wiring Diagrams
30) The USI of the Installed Software matches the Onsite Documentation

4.3.2.3 Top of Car (ASME A17.1.8.11.3.1.3)

1) Top-of-Car Stop Switch
2) Car Top Light and Outlet
3) Top-of-Car Operating Device
4) Top-of-Car Clearance and Refuge Space
5) Normal Terminal Stopping Devices
6) Terminal Speed-Reducing Devices
7) Car-Leveling and Anticreep Devices
8) Speed Test
9) Top Emergency Exit
10) Floor and Emergency Identification Numbering
11) Hoistway Construction
12) Hoistway Smoke Control
13) Pipes, Wiring, and Ducts
14) Windows, Projections, Recesses, and Setbacks
15) Hoistway Clearance
16) Multiple Hoistways
17) Traveling Cables and Junction Boxes
18) Door and Gate Equipment
19) Car Frame and Stiles

20) Guide Rails Fastening and Equipment
21) Governor Rope
22) Governor Releasing Carrier
23) Wire Rope Fastening and Hitch Plate
24) Suspension Rope
25) Slack-Rope Device
26) Traveling Sheave
27) Counterweight and Counterweight Buffer
28) Crosshead Data Plate
29) Machinery Space/Control Space
30) Working Areas on the Car Top
    a. Means to prevent unexpected movement
    b. Unexpected car movement device
    c. Operating instructions for unexpected car movement device
    d. Operating instructions for egress and reentry procedure
31) Equipment Exposure to Weather
32) Machinery Supports and Fastenings
33) Guarding of Equipment
34) Broken Rope, Chain, or Tape Switch

4.3.2.4 Outside of Hoistway (ASME A17.1.8.11.3.1.4)

1) Car Platform Guard
2) Hoistway Doors
3) Vision Panels
4) Hoistway Door Locking Devices
5) Access to Hoistway
6) Power Closing of Hoistway Doors
7) Sequence Operation
8) Hoistway Enclosure
9) Elevator Parking Devices
10) Emergency Doors and Blind Hoistways
11) Standby or Emergency Power Selection Switch
12) Means Necessary for Tests
13) Inspection and Test Panel, Inspection Operation, and Inspection Operating with Open Door Circuits
14) Equipment Exposure to Weather

4.3.2.5 Pit (ASME A17.1.8.11.3.1.5)

1) Pit Access, Lighting, Stop Switch, and Condition
2) Bottom Clearance, Runby, and Minimum Refuge Space
3) Plunger and Cylinder
4) Car Buffer
5) Normal Terminal Stopping Devices
6) Traveling Cables
7) Car Frame and Platform
8) Car Safeties and Guiding Members
9) Machinery Space/Control Space

10) Working Areas in the Pit
    a. Means to prevent unexpected movement
    b. Unexpected car movement device
    c. Operating instructions for unexpected car movement device
    d. Operating instructions for egress and reentry procedure
11) Equipment Exposure to Weather
12) Machinery Supports and Fastenings
13) Guarding of Equipment
14) Pit Inspection Operation
15) For seismic risk zones, overspeed valve and pipe supports

4.3.2.6 Firefighter's Service (ASME A17.1.8.11.3.1.6)

1) Check that the monthly operation log is maintained

4.3.2.7 Working Platforms (ASME A17.1.8.11.3.1.7)

1) Working Platforms
    a. Operating Instructions
2) Retractable Stops
    a. Retractable Stop Electrical Device
3) Inspection Operation

4.4 Testing

The Code requires periodic testing of elevators completed by qualified elevator personnel and witnessed by a QEI. After testing, a report must be written and submitted by the QEI containing the date of the inspection, the type of tests performed, detail results of the tests, and any code deficiencies noted including a statement as to corrective action taken, if any.

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

4.4.1 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.

4.4.1.1 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 and functions:

1) Oil buffers (ASME A17.2.5.9.2.1)
2) Safeties (ASME A17.2.2.29.2(a))
3) Governor (ASME A17.2.2.13.2.1(a))
4) Slack-rope devices and stop motion switch on winding-drum machines (ASME A17.2.2.20)

5) Standby power operation (ASME A17.2.1.17.2.1)
6) Power operation of the door system (ASME A17.2.1.8.2)
7) Firefighters' service (ASME A17.2.6)
8) Normal terminal stopping devices (ASME A17.2.28.2.1(a))
9) Final terminal stopping devices (ASME A17.2.3.6.2.1(a))
10) Broken rope, tape, or chain switch (ASME A17.2.3.26.1)
11) SIL-rated electrical devices (per manufacturer checkout procedure)
12) Ascending car overspeed protection and unintended car movement devices, and emergency brake (ASME A17.2.2.43.2.1(a))
13) Traction-loss detection means (ASME A17.1.8.6.4.19.12)
14) Broken-suspension-member and residual-strength detection means (ASME A17.2.3.23.2.1)
15) Occupant evacuation operation – for guidance use the Acceptance Checklist For Occupant Evacuation Operation in Nonmandatory Appendix I of ASME A17.2. A record of this checklist shall be made available to the building owner and AHJ.
16) Emergency communications (ASME A17.2.1.6.2)
17) Means to restrict hoistway or car door opening (ASME A17.2.1.18.1)
18) Earthquake operation (Seismic Risk Zone 2 or higher)
19) Inside of car (ASME A17.2.1.20)
20) Machine Room (ASME A17.2.42.1 & ASME A17.2.42.1.1)
21) Top of Car – perform tests and inspections in accordance with the procedures laid out in the applicable parts of ASME A17.2.3.34.
22) Elevator Pit (ASME A17.2.5.16.1 & ASME A17.2.5.16.1.1)
23) Door reopening device(s) (ASME A17.2.1.1.1)
24) Sequence operation of power door systems (ASME A17.2.4.7)
25) Testing of alternative arrangements and equipment (per manufacturer checkout procedure)

4.4.1.2 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 and functions. For Category 5 Tests, follow the procedures laid out for the Category 1 Tests unless noted below:

1) Oil buffers (ASME A17.2.5.9.2.1(b))
2) Safeties (ASME A17.2.2.29.2(e))
3) Governor (ASME A17.2.2.13.2.1(b))
4) Braking system (ASME A17.1.8.6.4.20.10)
5) Drive Machine Brake (ASME A17.2.2.17.2.1(b))
6) Emergency terminal stopping and speed-limiting devices (ASME A17.2.5.3.2.1(b))
    a. For static control elevators use ASME A17.2.2.28.2.1(b)
7) Inner landing zone (ASME A17.1.8.6.4.20.9)
8) Power opening of doors (ASME A17.2.1.10.2(b))
    a. For static control elevators use manufacturer checkout procedure
9) Emergency brake (ASME A17.1.8.6.4.20.11)
10) Leveling zone and leveling speed (ASME A17.1.8.6.4.20.8)

4.4.2 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.

4.4.2.1 Category 1 Tests - Hydraulic Elevators

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

1) Relief valve setting and system pressure (ASME A17.2.2.31.2.2)
2) Hydraulic cylinders and pressure piping (ASME A17.2.36.2.2)
3) Flexible hose and fitting assemblies (ASME A17.1.8.6.5.14.4)
4) Power operation of door system (ASME A17.1.6.5.14.6)
5) Slack-rope device (ASME A17.2.3.31.2)
6) Alternative arrangements of equipment (per manufacturers checkout procedure)
7) Earthquake operation (Seismic risk zone 2 or higher) (ASME A17.2.2.42.3.2)
8) SIL rated electrical devices (per manufacturer checkout procedure)
9) Standby or emergency power operation (ASME A17.2.1.17.2.2)
10) Firefighters' service (ASME A17.2.6)
11) Normal terminal stopping devices (ASME A17.2.2.28.2.2)
12) Sequence operation of power door systems (ASME A17.2.4.7.1)
13) Emergency terminal speed-limiting devices and emergency terminal stopping devices (ASME A17.2.3.6.2.2)
14) Pressure switch (ASME A17.2.2.37.2.2)
15) Oil buffer (ASME A17.2.5.9.2.1(a))
16) Safety (ASME A17.2.2.29.2(a) or ASME A17.2.5.8.2.2)
17) Governor (ASME A17.2.2.13.2.2(a))
18) Low oil protection operation (ASME A17.2.2.39.2)
19) Auxiliary power lowering device (ASME A17.2.2.44.2.2)

4.4.2.2 Category 3 Tests - Hydraulic Elevators

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

1) Unexposed portions of pistons (ASME A17.2.5.11.1.2)
2) Pressure vessels (ASME A17.2.2.33.2.2)

4.4.2.3 Category 5 Tests - Hydraulic Elevators

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

1) Oil buffer (ASME A17.2.5.9.2.1(b))
2) Safety (ASME A17.2.2.29.2(e))
3) Governor (ASME A17.2.2.13.2.2(b))
4) Coated ropes (ASME A17.2.3.23.2.2)
5) Wire rope fastenings (ASME A17.2.3.22.1.1)
6) Plunger gripper (ASME A17.2.5.17.2.2(b))
7) Overspeed valve (ASME A17.2.5.15.2.2)
8) Drive machine brake (ASME A17.2.2.17.2.2)

5.0 Modernization

The maintenance program is in place to keep the elevator equipment in proper working order as originally designed and maintain safe operations. A well-run maintenance program also incorporates life cycle costs for long-term asset management. Elevator code, preventative and corrective maintenance, reliability, and repair part availability will help determine scope and timing of a modernization. When modernizing components, any change to the original designs is considered an Alteration. An Alteration invokes additional ASME A17.1/CSA B44 requirements and that portion of the elevator will need to be brought up to current code requirement. New or altered installations of both electric and hydraulic elevators are subjected to acceptance inspections and tests before being placed in service. ASME A.17.1/CSA B44 should be referenced to determine any requirements, and a new code data plate should be provided. Most facilities handle modernization through contractual means. The following information should be considered when an overhaul or modernization of an elevator is required.

5.1 Life Expectancy

An elevator's life expectancy will be dependent on the amount of use, environmental conditions, and the quality of the maintenance program. A general rule of thumb is that an elevator may require modernization after 20-30 years of use. This need may only be applicable to certain components. Some components typically have much shorter life expectancies and will be replaced throughout the life of an elevator. On the other hand, many components, when maintained well, can greatly exceed the 20-30 year timeframe. Candidates most likely to need modernization would be controls, and control, electrical, and hoisting equipment. During an elevator's life, the elevator code requirements will more than likely shift, but excluding alterations, the equipment modernized will only need to meet the code from the time when the elevator was installed or last altered.

5.1.1 Considerations

The following are general considerations when trying to determine to move forward with a modernization:

5.1.1.1 Safety

Is there any chance of a loss of equipment integrity or personnel safety? An example of this might be associated with pre-1970 Hydraulic Elevators. The Code did not require hydraulic elevators to possess a safety bulkhead until 1970. 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. The environmental impact of hydraulic fluid leakage is another serious consideration that should be a factor in deciding to replace hydraulic hoist components. 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 more recent design development. Older hydraulic elevators were installed with steel liners, which are more susceptible to corrosion attack. These hydraulic elevators shall be scrutinized and frequently checked for leakage until modernized. Safety technology is continuously advancing and new methods for keeping personnel safe while in, on, and around elevators is extremely important. During modernization, safety should always be

considered whether that means adding safety features or upgrading existing features to more modern devices.

5.1.1.2 Accessibility

New elevators are required to meet the requirements of Americans with Disabilities Act - Accessibility Guidelines (ADAAG) of 28 CFR Part 36 Appendix A. 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.

5.1.1.3 Performance

Does the equipment perform its intended function routinely and with minimal issues? Does a need exist to improve performance or reliability? An obvious form of reliability issues would be any form of unintended motion or stopping between floors.

5.1.1.4 Maintenance

When it comes to maintenance, consider how much time and energy is continually needed to maintain or get the elevator working again. Is it becoming more expensive to maintain the existing equipment over upgrading? Will upgrading reduce the quantity or type of maintenance? Are repair and replacement parts readily available or are long lead times and special contracts to manufacture parts becoming more frequently encountered? Is the equipment getting close to recommendation modernization timelines?

6.0 Service Agreements

For various reasons, some facilities choose to have service agreements in which a contractor performs the required elevator maintenance, inspections, and testing. When doing so, it is beneficial to have a well written document that clearly defines the scope of work as well as the contractor's responsibilities and qualifications.

6.1 Types of Agreements

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

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.

6.2 Full-Service Agreement

A full-service maintenance agreement shall include the following standard items (as applicable):

6.2.1 Description of Elevator(s)

A description of the elevator(s) should include:

- 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

6.2.2 Term of Service

- 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.

6.2.3 Hours of Service

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

6.2.4 Service Technical Requirements

- Work will be performed by trained and qualified personnel, directly employed and supervised by the Service Contractor.
- Personnel will be required to perform work in a neat and 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.

6.2.5 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.

6.2.6 Scope of Work

Ensure the scope of work includes the maintenance program requirements discussed in section 4.0 and the necessary frequency of maintenance from FIST 4-1B, *Maintenance Scheduling for Electrical Equipment*.

6.2.7 Performance

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

6.2.8 Miscellaneous

- Reclamation shall define the terms and method of payment.
- Reclamation shall provide a mechanism for dispute resolution as an alternative to litigation.
- Reclamation shall include provisions for curing a breach of contact 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.

6.2.9 Recordkeeping

- Reclamation shall maintain all records in accordance with the Information Management Handbook as referenced in Reclamation manual Directive and Standard, Information Management (RCD 05-01).

Appendix A – Definitions

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.

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 capacity.

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 alternate level 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.

Firefighter's service, 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.

Firefighter's service, Phase II: The operation and control of the elevator by firefighters (or emergency personnel), effected by keyswitch.

Fire resistance rating: The measured time that a material will withstand fire exposure.

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 car.

Hydraulic jack: A cylinder equipped with a plunger/piston, which applies the energy provided by a pressurized liquid (hydraulic fluid).

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 and safety.

Machine: A power unit that provides the energy to raise and lower the elevator car.

Machine, Electric: The energy is provided by an electric motor. It includes the motor, brake, driving sheave/drum, and gearing. The most common are: (1) the geared-traction (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 gearless-traction types (without intermediate gearing, in which the motion of the car is obtained through friction between the hoist ropes and a traction sheave).

Machine, Hydraulic: 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 Alteration.

Motor-generator set: An ac motor that drives a dc generator to provide power to the dc elevator machine.

Operation: A method of actuating (starting, stopping, direction) motion control.

Operation, automatic: Car motion started by operating devices (e.g., pushbutton) in the car or at a landing and stopping automatically at landings.

Operation, group automatic: 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.

Operation, nonselective collective: 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.

Operation, Selective collective: 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).

Operation, Single automatic: Automatic operation in which the call that is registered first is answered before subsequent calls are addressed.

Operation, Preregister: 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.

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

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

Operation, Signal: 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.

Operation, Continuous pressure: 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.

Rope, Hoist: Supports, raises, and lowers the car and counterweight.

Rope, Compensating: 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.

Rope, Governor: 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.

Sheave, Compensating: Used to keep the compensating ropes taut.

Sheave, Deflector: Used to change the direction of the hoist ropes.

Sheave, Driving: Part of the electric hoist machine that the car and counterweight hoist ropes pass over.

Sheave, Overhead: Used to reverse the direction of the hoisting ropes when the machine is located at the bottom of the hoistway.

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

Sheave, 2:1: 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.

Terminal stopping device: Slows and stops the car automatically at a terminal landing, independent of the normal stopping means.

Final: Cuts power automatically from the motor and brake (or from a hydraulic machine) when the car has passed a terminal landing.

Travel: The distance the elevator car travels between the top and bottom landing levels.

Traveling cable: The set of flexible electrical conductors that connects 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, allowing the cable to remain connected to the car as it travels.

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.