Fresno Fire Department

Elevator Operations Rescue Guide

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PURPOSE

This Guide provides information on the operation and design of common elevators found in the City of Fresno. Personnel should consider this information when using elevators during emergency and/or rescue operations.

Application

Although all high-rise elevators are electrically powered and perform the same basic function, there are a variety of different elevator designs. This guide is not designed to cover all the different types of elevator systems and individual items unique to each one. This guide will give an overview of the most typical elevators. Because elevator systems are so different and can be very complex, first-hand knowledge of each elevator system should be developed through effective pre-fire planning with pertinent elevator operation cards, which are placed in a building lock box.

ELEVATOR TYPES

There are three (3) main types of elevators commonly used: hydraulic, traction with a machine room, and machine-room-less traction; however, there are variations on each type.

Hydraulic Elevators

Hydraulic elevators are supported by a piston at the bottom of the elevator. An electric motor forces hydraulic fluid into the piston pushing the elevator up. The elevator descends as a valve releases the fluid from the piston. Hydraulic elevators are used for low-rise applications of 2-8 stories and travel at a maximum speed of 200 feet per minute. The machine room for hydraulic elevators is located at the lowest level adjacent to the elevator shaft.

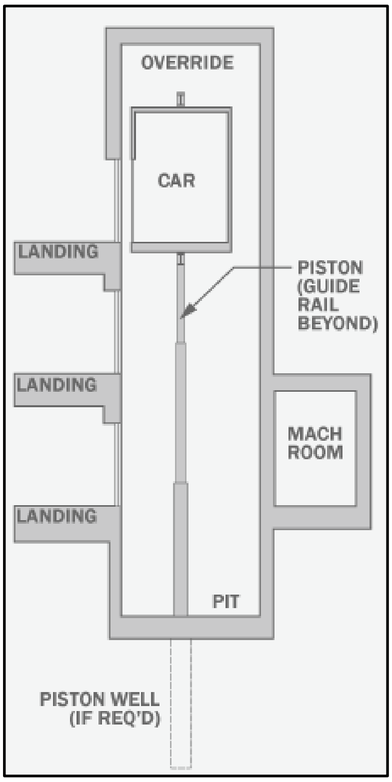

Figure 1 - Hydraulic Elevators

Conventional hydraulic elevators have a sheave that extends below the floor of the elevator pit, which accepts the retracting piston as the elevator descends. Some configurations have a telescoping piston that collapses and requires a shallower hole below the pit. Max travel distance is approximately 60 feet.

Hole-less Hydraulic elevators have a piston on either side of the cab. In this configuration, the telescoping pistons are fixed at the base of the pit and do not require a sheave or hole below the pit. Telescoping pistons allow up to 50 feet of travel distance. Non-telescoping pistons only allow about 20 feet of travel distance.

Roped/Cable hydraulic elevators use a combination of ropes/cables and piston to move the elevator. Maximum travel distance is about 60 feet.

Traction Elevators

Traction elevators are lifted by ropes/cables, which pass over a wheel attached to an electric motor above the elevator shaft. They are used for mid and high-rise applications and have much higher travel speeds than hydraulic elevators. A counterweight makes the elevators more efficient by offsetting the weight of the car and occupants, so the motor does not have to move as much weight. There are two types of traction equipment:

- High speed direct traction or gearless type traction consists of a slow speed DC motor directly coupled to a traction sheave with a brake wheel mounted on the motor shaft.

- Geared traction type uses a high-speed motor. The motor is geared to a traction sheave through worm gears with a brake wheel between the worm gears and motor.

Since there is less weight and equipment with traction type elevators, the equipment room is **usually** located on the roof or above an elevator shaft in high-rise buildings

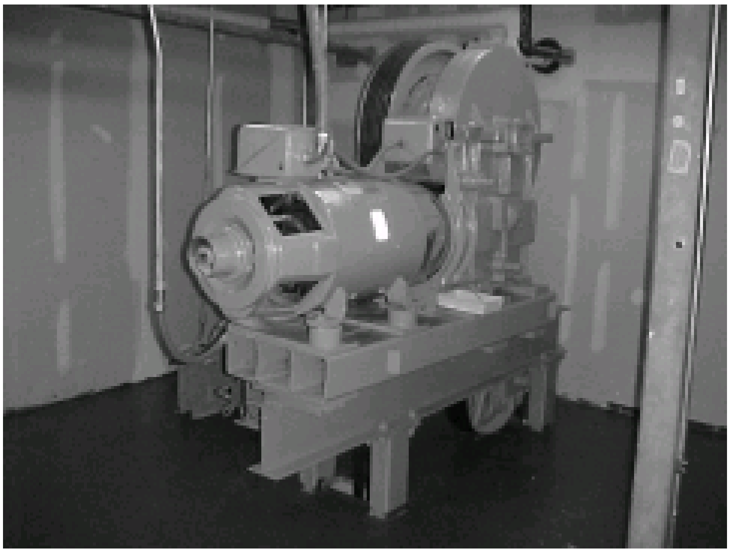

Figure 2 - Traction Elevator Machine Room

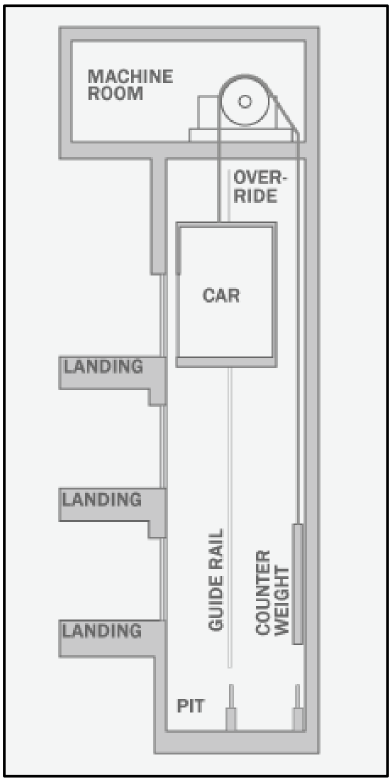

Figure 3 - Traction Elevator with Machine Room

Machine Room-Less (MRL) Elevators

Machine Room-Less Elevators are traction elevators that do not have a dedicated machine room above the elevator shaft. The machine sits in the override space and is accessed from the top of the elevator cab when maintenance or repairs are required. The control boxes are in a control room that is adjacent to the elevator shaft on the highest landing and within around 150 feet of the machine. When these systems are encountered, having a qualified elevator mechanic on-scene is an invaluable resource during a detailed rescue operation.

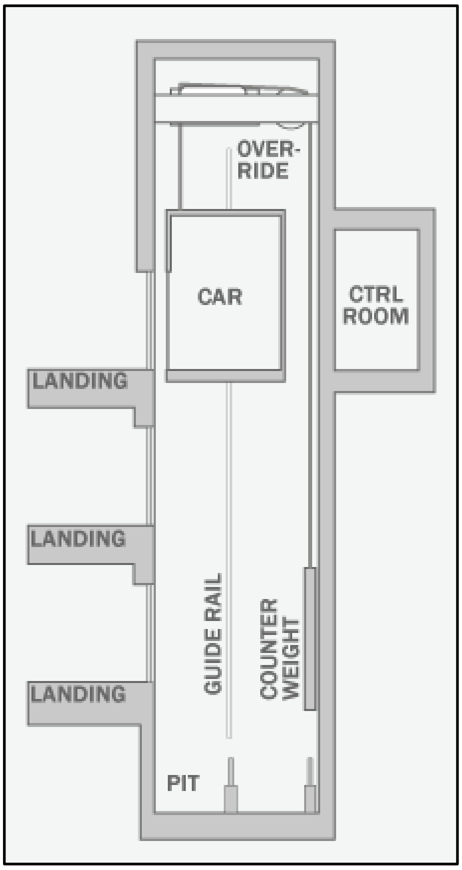

Figure 4 – Machine Room-Less (MRL) Elevator

HOISTWAYS

Elevator hoistways are the enclosed vertical shafts in which elevator cars travel. In buildings with multiple banks of elevators, cars in close proximity to each other utilize a common hoistway. Many of the newer high-rise buildings are equipped with multiple-bank elevator systems in which elevator cars service only a certain number of floors. Example: 20-story building--the low-rise bank serves floors 1 through 10 and the high-rise bank serves floor 1 and floors 11 through 20. Generally, the only location where transfer between split-bank elevators is possible is at ground level. Hoistways contain vertical rails that guide and stabilize each individual elevator car during travel. Final limit switches are mounted on the rails, which act to limit the maximum upward and downward travel of each car. Elevator counterweights are found in the hoistway, generally at the rear of the shaft.

ELEVATOR DOOR ARRANGEMENT

Buildings over three (3) stories in height are required to have mechanical ventilation provided to the hoistway. Hoistway doors at each floor served by an elevator car are opened and closed by movement of the elevator car door when the car is level with the floor landing. There are four (4) basic types of doors used on elevator hoistways and cars.

1. Single-slide doors
2. Multi-speed doors
3. Center-opening doors
4. Swing-hall doors.

Hoistway and elevator car doors may be of the same type or may be any dual combination of the basic types listed, dependent upon the age and manufacturer.

Single-Speed

One of the most common designs used today is the single-speed, side sliding entrance. This design features a single door panel that operates by sliding horizontally along the path of the sill and hangar-track assemblies.

Figure 5 - Single-Speed Sliding

Multi-Speed

The multi-speed door assembly refers to the two/three-speed, side-slide entrance, comprised of two/three door panels that work together, spreading across the entire hoistway opening (with each door panel covering a portion of the opening) when the entrance is in the closed position. Upon opening, the doors then slide to one side and stack one behind the other, collapsing into a space half as wide as the original hoistway opening. Since the leading door panel travels the entire opening width in the same amount of time as the trailing door panels travel half/third the distance, the leading and trailing door panels must travel at different speeds and are commonly referred to, respectively, as the fast and slow door panels.

Figure 6 - Multi-Speed

Center-Parting

Center-parting entrances are multi-paneled systems. Similar to multi-speed, side-slide entrances, center-parting entrances incorporate two or more door panels that work together to protect a hoistway opening. However, unlike side-slide entrances where all door panels slide in the same direction over to one side of the opening, the center-parting entrance door panels move in opposite directions to/from one another.

In single-speed, center-parting entrances, for example, two door panels work together, spreading across the entire hoistway opening when the entrance is in the closed position. Each door panel covers half of the opening, with the leading edges meeting in the middle of the hoistway opening. Both doors then move away from each other at the same speed, parting in the center, with one door moving to the left side of the opening as the other door moves to the right.

Figure 7 - Center Parting

Swing Doors

Not all installations can be covered by the sliding elevator-entrance design (either side-slide or center-parting). Swing-door entrance assemblies are used in installations not requiring automatic operation of the hoistway-door equipment (residence lifts) or older, retrofit sites with extremely tight shafts (sufficiently tight that a collapsible car gate must be used, since there is not enough door-travel room for even the smallest door-paneled multi-speed entrance). These entrances employ doors that swing open and closed on hinges/pivots that affix the “back” or “trailing” edge of the door to one side of the entrance frame.

Figure 8 - Swing Door

POWER SYSTEM

High-rise elevators are almost universally driven by electric motors located in a machinery room above the hoistway. Power to the drive motor may range from 220 volts to 660 volts and up to 150 amps. Voltage from the machinery room through cables to the elevator car will usually not exceed 220 volts and 5 amps. Some older installations utilize alternating current (AC) to power the elevator drive system; however, many high-rise elevators are equipped with motor generators, which convert alternating current to direct current (DC) to power the drive motor. The direct current motor generator system provides smoother, more positive movement of elevator cars and operates more efficiently than other designs.

Elevator drive motors are connected through a brake mechanism to a drive sheave, which controls the cables (referred to as hoisting ropes) that move the elevator car in the hoistway. The drive motor, brake mechanism, and drive sheave are often built into one assembly, referred to as an elevator machine. The brake mechanism is a safety device, preventing movement of the elevator car any time power is not being applied to the drive motor.

Located in the machinery room, usually separate from the drive system, is a governor device connected by cable to the elevator car. The governor device acts to engage safety mechanisms, which slow or stop the elevator whenever its vertical travel exceeds a predetermined speed in feet per minute. If the elevator car is traveling too fast in a downward direction, the governor cable will automatically cause the safety devices on the elevator car to grip the hoistway guide rails and stop the car. If the upward travel speed becomes excessive, the governor device will cause a shutdown of electrical power to the drive motor and actuate the brakes on the motor.

Electrical shutoff switches that control the power to the drive motors are normally located in the machinery room. A separate switch is required for each individual elevator drive motor and should be numbered to correspond with the numbering of individual elevator units. Some of the newer high-rise buildings are equipped with emergency power systems, which may be used to perform selective elevator functions if the normal power supply should fail. Because of modifications and revisions made to applicable codes during recent years, the existence of a standby emergency power system in a building does not automatically ensure emergency operation of elevators. This information should be obtained from building management personnel and confirmed by actual field testing.

CARS

Elevator cars are constructed of a cage of light metal or metal-backed decorative panels supported by a heavy steel vertical sling or upright frame. The steel double beam forming the top cross member of the sling is referred to as the crosshead and to this are fastened the hoisting ropes and upper guide shoes. The bottom cross member, of equally heavy construction, is called the safety plank and supports the car floor or platform. Attached to the safety plank are the car safety mechanisms and the lower guide shoes. The car floor is usually constructed of an angle iron or channel iron frame on top of which are two levels of wood flooring and a finished surface of linoleum, rubber, asphalt tile, or carpeting. Often a sheet of light-gauge steel encloses the under surface of the car floor.

Freight elevators may be equipped with heavy steel, diamond-plate flooring. The guide shoes, bolted to the upper and lower cross members, keep the elevator car in sliding contact with the hoistway guide rails to prevent sway or lateral movement. The safety mechanisms attached to the lower cross member are activated by the governor device and are designed to stop the car by clamping the guide rails if the car descends too fast or falls due to broken hoisting ropes. On lower speed cars, safety mechanisms are of an instantaneous type and will stop the car in a very short distance. On high-speed cars to prevent injuries to passengers, the safety mechanisms are applied gradually to stop the car within a specified distance.

The dead weight of an average elevator car may vary from 1,500 to 3,000 pounds, with large capacity or industrial elevator cars weighing as much as 5,000 pounds. The live weight (passenger load) permitted in elevator cars is normally computed at 150 pounds per square foot of floor area. Counterweights are used on elevator cars to permit a balanced operation at all levels and to allow the use of smaller driving machinery. Normally, the counterweight equals the total weight of the car plus 40 percent of the capacity of the car. The hoisting ropes (cables) fastened to the top cross member of the elevator car support the total weight of the elevator car and provide vertical movement. The total number of hoisting ropes attached to an elevator car will vary according to the weight of the car (usually numbering between two and six). The governor rope, which activates the safety mechanisms, is also attached to the car. Other ropes that may be attached to the car include counterweight ropes, compensating ropes or chains to balance the weight of hoisting ropes, and electric cables to supply electrical power to the car.

Current building code provisions require elevator cars be equipped with emergency exits. Most elevators will have an emergency exit at the top of the car. On older elevator cars top exits are required to be openable from both inside and outside the car without the use of special tools. On new cars the top exit may be opened only from the outside.

CONTROLS

Electric elevators in high-rise buildings are all designed to operate under the same basic control method. However, total control systems will vary from simple automatic self-service controls found in older buildings to the sophisticated computerized multi-unit control systems in the newest, high-rise buildings. Elevator controls are covered under the following categories:

Lobby Control Panels

Lobby control panels vary in appearance and total function. These panels are generally equipped with special emergency service or bypass switches. Activation of this switch to the on position will cause the elevator controlled by the switch to immediately disregard all activated call buttons, return the elevator car to ground level, and open the elevator door. The system will stay in this mode unless a selective mechanical control override is used on the individual car or the system is restored to automatic operation. Emergency recall of all elevator cars to the lobby under fire conditions is required for four (4) important reasons:

1. Prevent smoke or fire from entering cars or hoistways through open car and hoistway doors.

2. Reduce the possibility of occupants becoming trapped in cars at dangerous locations.

3. Make it easier to account for all elevator cars.

4. Provide access to elevators for Department members.

Some new elevator installations are equipped with control panels with displays indicating floor location of individual cars and the direction in which they are traveling. Many lobby panels provide key switches that will shut off the motor generators supplying electric power to the elevator drive motors.

Call Switches

Elevator call switches are located at each landing served by an elevator as a means of summoning an elevator car to the floor. These switches, or buttons as they are more commonly referred to, are either mechanical switches activated by a slight pressure or electronic switches activated by completion of a circuit to ground through the person touching the button. Activation of a call button causes relay equipment in selector apparatus at the machinery room or computer to move an elevator car to the requested floor location. Laboratory tests and actual experiences have shown some mechanical and electronic touch buttons can be activated by moderate heat sources that are present under fire conditions (4500 F to 5000 F) or by moisture in call switches or relay and selector equipment. The possibility of malfunction of such systems reinforces the need for emergency service features, which will provide a method of placing elevator cars out of service at ground level, allowing manual operation by firefighting members.

Car Control Panels

Individual panels inside each elevator car provide control over the car allowing movement to a desired location and provide various other features. Floor selector switches or buttons are, in most cases, identical in design and operation to call switches and are subject to the same possible malfunction under fire conditions.

All electrically operated elevators are required to have an emergency stop switch incorporated into the car control panel. Activation of the emergency stop switch will cause a shutdown of power to the elevator drive motor and bring the car to a safe stop regardless of its position in the hoistway. Elevators utilizing power operated doors are required to have a close-door switch which, when activated, will cause the car door to close and remain closed until the door opening mechanism is engaged by activation of another switch or movement of the elevator car to another floor.

Alarm buttons located on car control panels are required to sound an audible alarm within the building and may be supplemented with, or used in lieu of, telephones installed in the elevator car. Elevator telephones may terminate within the building or be connected to an outside central telephone exchange or security service. Car control panels in most high-rise elevators are equipped with switches that will override the automatic control features placing the individual car on manual operation.

New elevator installations provide a key switch sometimes referred to as a firefighters' service switch, which allows manual operation of the elevator and provides certain added safety features. The additional safety features include the requirement of depressing the door-open button to open elevator doors on arrival at the selected floor. In this mode, the door-open button must be depressed until the doors are in a fully opened position. If released prior to full opening, the doors will automatically close.

Photo-Detector Devices

Many new elevators are equipped with photo-detector (electric-eye) devices, which cause elevator doors to reopen whenever the light beam is broken during the door-close cycle. Some elevators with this feature have a force-close mechanism, which will override the photo-detector device if the light beam is broken for a preset time (usually 30 seconds). Elevators equipped with the photo-detector device, but lacking the force-close mechanism, may remain open indefinitely at a fire floor if the smoke reaches a density sufficient to obscure the light beam. Doors equipped with photo detector devices are required to have a push-type switch for use by elevator occupants who will override the photo-detector device and cause the doors to close immediately. This switch is usually labeled “TO BE USED IN CASE OF FIRE ONLY”.

Miscellaneous controls included in elevator car panels are usually installed for maintenance or service functions. These functions include items such as convenience lighting, car ventilation, etc., and will vary with the age and manufacture of the elevator. In certain buildings service to one or more floors by elevator may be restricted for security reasons. To gain access to these floors, a special key switch, located next to the floor selector button, must be activated. Normally, the emergency service switch key may be used to activate a floor selector lock-out switch.

INFORMATION

There are three (3) main reasons that elevators become stalled in hoistways:

1. Electrical power failure.
2. Malfunction of control components.
3. Activation of safety devices.

Regardless of the reason, trapped passengers are usually in no immediate danger and there is no reason to endanger the lives of firefighting members or civilians by engaging in high-risk rescue operations. In many of these situations, it is best to wait for the arrival of elevator repair technician who can usually correct the problem and release the passengers in a very short time without undue hazard to the car occupants and damage to elevator equipment.

Elevator companies normally have trained personnel on duty or on call 24 hours a day. Their knowledge and familiarity with the elevator system allow them to quickly determine the reason for the elevator stalling and restore it to normal operation.

ELEVATOR RESCUE

Reference: Standard Operating Procedures Section 202.005b, Elevator Rescue Operations)

REFERENCES

Standard Operating Procedure:

Section 202.005a, Elevator Rescue

Section 202.005b, Elevator Rescue Operations

Guides:

High Rise Guide