



Elevator Installation

for Buildings Located in Special Flood Hazard Areas in
accordance with the National Flood Insurance Program

Technical Bulletin 4 / November 2010



FEMA

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Technical questions or comments about this technical bulletin should be addressed to the Flood/Wind Building Science Helpline at FEMA-Buildingsciencehelp@dhs.gov or by calling 1-866-927-2104. Questions are responded to within 5 working days.

Technical Bulletin 4-10 replaces Technical Bulletin 4-93, *Elevator Installation for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program.*

Cover image: Looking down on a traction elevator system that sustained damage due to direct contact with floodwaters, including rusting and deterioration of the cab and other elements.

Introduction

Protecting buildings constructed in special flood hazard areas (SFHAs) from damage caused by flood forces is an important objective of the National Flood Insurance Program (NFIP). In support of this objective, the NFIP regulations include minimum building design criteria that apply to new construction, repair of substantially damaged buildings, and substantial improvement of existing buildings in SFHAs. The base flood is used to delineate SFHAs on Flood Insurance Rate Maps (FIRMs) prepared by the NFIP. The base flood is the flood that has a 1-percent chance of being equaled or exceeded in any given year (commonly called the “100-year” flood). Key terms used in this Technical Bulletin are defined in the Glossary.

Lowest floor means the lowest floor of the lowest enclosed area (including a basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area is not considered a building's lowest floor provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of Sec. 60.3.

In many cases, the NFIP requires that buildings in the floodplain be elevated several feet above the ground. As a result, use of elevators within SFHAs is becoming more common in residential and non-residential construction to facilitate access and to comply with the standards outlined in the Americans with Disabilities Act of 1990 (ADA).

Many local jurisdictions require that a safety factor, or “freeboard,” of 1 to 3 feet be incorporated into the design elevation for a structure, to raise it above the “100-Year” flood. The base flood elevation (BFE) plus freeboard is referred to as the design flood elevation (DFE).

This Technical Bulletin provides information on the proper installation of elevators in SFHAs to reduce flood damages. Elevator types and their associated equipment are described, along with practical methods of protecting elevators from flood damage.

The guidelines within this bulletin meet NFIP regulations pertaining to elevators. These recommendations serve to encourage loss prevention measures that reduce the level of damage that can occur, the resultant repair costs, and the time the elevator is out of service. If these guidelines are followed, restoration of elevator service to the building can be accomplished as quickly as possible once floodwaters recede and power is restored.

NFIP Regulations

The NFIP regulations for utility systems, including elevator equipment are codified in *Title 44 of the Code of Federal Regulations*, Section 60.3(a). General guidance for systems can be found in paragraph 60.3(a)(3), which states that the community must:

Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding. If a proposed building site is in a floodprone area, all new construction and substantial improvements shall... be constructed with materials resistant

to flood damage, (iii) be constructed by methods and practices that minimize flood damages, and (iv) be constructed with electrical...equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

As these regulations indicate, all appropriate measures must be taken to mitigate flood damage to elevators and associated equipment to the maximum extent possible. Although some components must be located below the lowest floor of a building (i.e., below the BFE) to function, most elevator components vulnerable to flooding can be located above the BFE or be designed to minimize flood damage.

The NFIP Technical Bulletins provide guidance on the minimum requirements of the NFIP regulations. Community or State requirements that exceed those of the NFIP take precedence. Design professionals should contact the community to determine whether more restrictive provisions apply to the structure or site in question. All other applicable requirements of the State or local building codes must be met for buildings in flood hazard areas.

Flood Insurance Considerations

NFIP floodplain management regulations restrict use of the area below the lowest elevated floor of an elevated building to vehicle parking, building access, and storage. Elevators, just as stairs and ramps, are permitted for building access. Although elevators and elevator enclosures are covered by flood insurance, their presence in a building, their size, and the manner in which they are constructed are factors in determining a building's flood insurance premium. The NFIP provides coverage for elevators and their related equipment as building property. Elevator cabs and attached electronics are always covered by the NFIP. However, the NFIP does not cover elevator-related equipment located below the lowest elevated floor in an elevated post-FIRM building, or installed below the Base Flood Elevation (BFE) after September 30, 1987.

For building risks located in Flood Zones AE and A1-A30, where the elevator shaft is not designed to automatically equalize hydrostatic flood forces on its exterior walls, the standard building insurance rate is subject to a minimal insurance rate loading, depending on the square footage of the elevator shaft and the elevation of the top of the enclosure floor level in relation to the BFE for the building's location. A separate loading is charged for any permanent machinery and equipment servicing an elevator located below the BFE. However, a rate reduction may apply for those building risks where the elevator shaft/enclosure is designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters.

For building risks located in Flood Zones VE and V1-V30, elevator enclosures/shafts whose walls surround the elevator car are always considered a building enclosure or an obstruction. The rates for those buildings with elevator enclosures/shafts that exceed 299 square feet in size, with breakaway walls, are subject to an insurance rate loading factor to be added to the

overall base rate. The amount of the insurance rate loading depends on (1) the actual square footage of the elevator enclosure/shaft, (2) the value of the machinery/equipment servicing the elevator, and (3) the elevation of the enclosure and machinery/equipment in relation to the BFE. The elevator rate loading could amount to a substantial increase in the base building insurance rate for buildings located in the V Zones.

Building and Residential Code Considerations

The NFIP minimum construction requirements are contained in the International Code Council Codes (I-Codes). The International Building Code (IBC) requires that buildings be designed and constructed in accordance with ASCE 24-05, *Flood Resistant Design and Construction*. The American Society of Mechanical Engineers (ASME) *Safety Code for Elevators and Escalators* (ASME 17.1-2007) also requires that elevators in structures in SFHAs be constructed in accordance with ASCE 24-05. ASCE 24-05 provides minimum requirements for flood damage-resistant design and construction of structures that are located in special flood hazard areas. It requires that utilities and utility equipment be:

- Located above the DFE unless location below that elevation is specifically allowed in ASCE 24 or the equipment *is designed, constructed, and installed to prevent floodwaters, including any backflow through the system, from entering or accumulating within the components*; and
- Installed and anchored to resist flood forces.

Utility equipment in Coastal High Hazard Areas (V Zones) must not be mounted on, pass through, or be located along breakaway walls.

ASCE 24-05 also requires the following for elevators:

- Elevator components located below the DFE should be constructed of flood damage-resistant materials and designed to resist physical damage during flooding; and
- If an elevator cab is designed to provide access to areas below the DFE, it must be equipped with controls that prevent the cab from descending into floodwaters.

Specific requirements for hydraulic and traction elevators are discussed in the sections that follow.

The International Building Code (IBC) and the International Residential Code (IRC) further require that utility equipment such as elevators located below the DFE be designed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy. Further installation requirements for the installation of sump pumps in elevator pits and the prohibition of HVAC equipment in elevator shafts can be found in the *National Fire Protection Association National Electrical Code* (NFPA 70) and the *International Mechanical Code*.

Types of Elevators

Elevators have residential and commercial classifications by the governing code: ASME A17.1. Elevators are vertical transports that move people or materials between the floors or levels of a structure. All elevators include a cab or platform that moves along rails located within a shaft and are powered by one or more motors. The differences between elevator systems are related to how the cab or platform is transported between levels. The two primary types of elevators used for residential and commercial buildings are hydraulic elevators and traction elevators. One key difference between hydraulic elevators and traction elevators is that hydraulic elevators push the elevator cab up using a piston and traction elevators hoist the elevator cab up with a traction motor.

Hydraulic Elevators

A hydraulic elevator consists of a cab attached directly or indirectly to a hydraulic jack. Hydraulic elevators can be classified as **direct acting** or **holeless**. In **direct acting hydraulic elevators**, the hydraulic jack assembly extends below the lowest floor into the pit area (Figure 1). In contrast, for **holeless hydraulic elevators**, the cylinder is placed in the shaft above the pit level (Figure 2). Both types of hydraulic elevators are operated by a hydraulic pump and reservoir, both of which are usually located in a room adjacent to the elevator shaft. Hydraulic elevators are generally used in **low-rise construction** for residential and commercial buildings. However, in recent years, traction elevators have become more common in low-rise residential construction.

Traction Elevators

Traction elevator systems are most commonly installed in **high-rise construction** for residential and commercial buildings. Traditional **geared traction elevator** systems consist of cables connected to the top of the cab operated by an electric motor located in a penthouse above the elevator shaft, as shown in Figure 3. Traction elevators may be geared or gearless based on building height, speed requirements, and cost considerations. Geared traction elevators are typically used for small low-rise structures; while more expensive gearless traction elevators tend to be used for larger high-rise structures where speed is critical. New **machine room-less (MRL) traction elevators** employ a similar mechanical arrangement to geared traction elevators; however, the machinery is located within the elevator shaft at the top of the hoistway, as shown in Figure 4.

For the purposes of this technical bulletin, **low-rise construction** includes all buildings that fall within the scope of the *International Residential Code*® (IRC®) and other low-rise structures that fall within the scope of the *International Building Code*® (IBC®). This includes single-family houses, two-family houses (duplexes), and buildings consisting of three or more townhouse units and limited to three stories above grade as well as non-residential buildings less than 75 feet above grade.

For the purposes of this technical bulletin, **high-rise construction** includes all residential buildings and other high-rise structures that fall within the scope of the *International Building Code*® (IBC®). This includes single-family houses, two-family houses, and townhouses four or more stories above grade as well as non-residential buildings greater than 75 feet above grade.

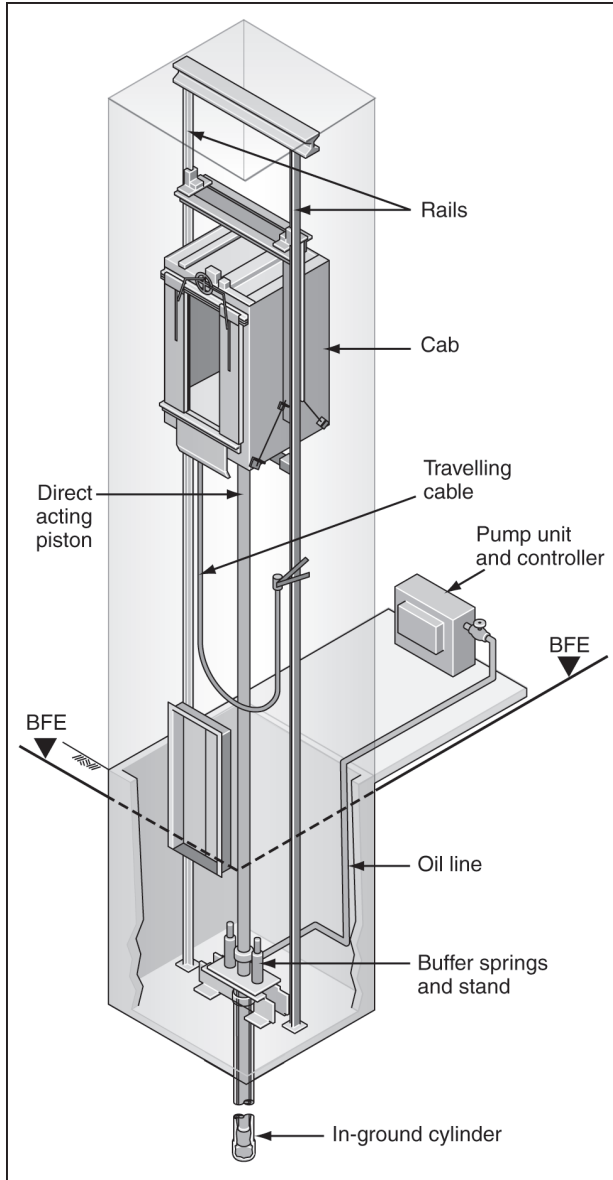


Figure 1. Direct Acting (Holed) Hydraulic Elevator
(Source: Otis Elevator Company)

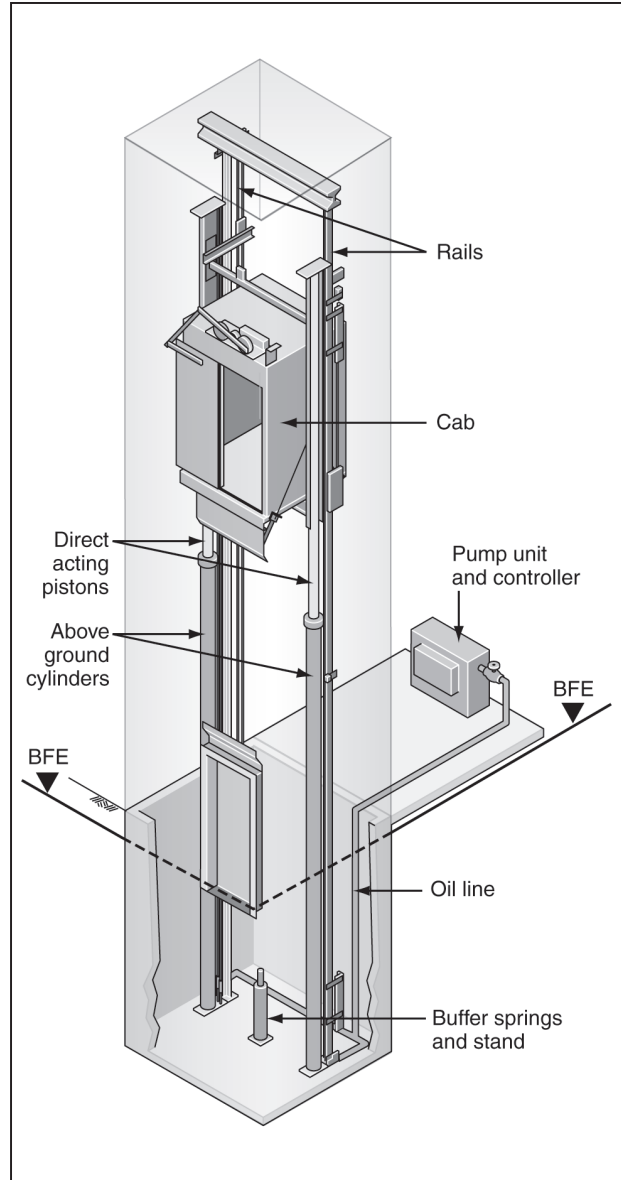


Figure 2. Holeless Hydraulic Elevator
(Source: Otis Elevator Company)

Other Conveyance Mechanisms

Pneumatic elevators are small, vacuum-like elevators typically found in residences. Pneumatic elevator cabs are controlled by a roof-mounted suction system. Although pneumatic elevators are generally less expensive than hydraulic elevators for single-family residences, they are not as widely used because the technology is relatively new and the cabs tend to be small. Pneumatic elevator systems are usually inside buildings; so they are typically located above the BFE.

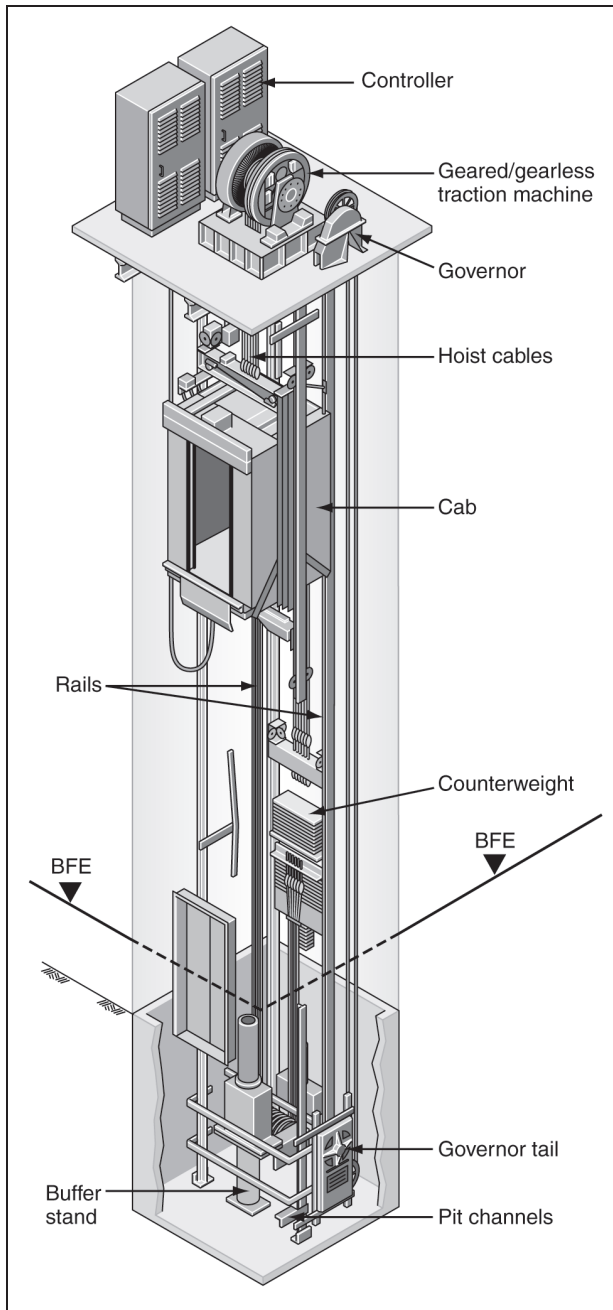


Figure 3. Traction Elevator
 (Source: Otis Elevator Company)

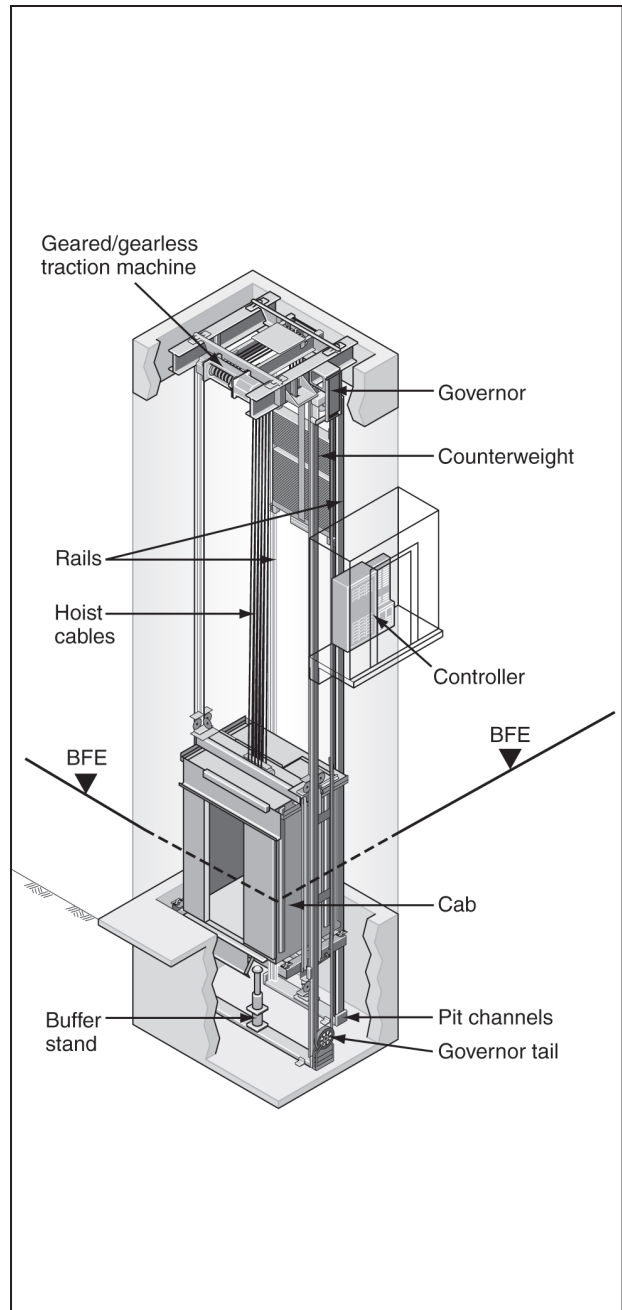


Figure 4. Machine Room-Less (MRL) Traction Elevator
 (Source: Otis Elevator Company)

Chairlifts are conveyance mechanisms installed over or alongside a staircase to transport occupants between floors. Chairlifts are designed to operate inside a structure; therefore, chairlifts and associated equipment are usually located in the elevated part of the structure above the BFE or protected by other measures.

Vertical platform lifts (VPLs) are designed to transport an individual in a wheelchair from one level to another. They are usually designed so that a wheelchair user can enter the lift on one

side and exit on another (i.e., the lift has two doors). VPLs are used indoors above the BFE or outdoors below the BFE and are either open (i.e., bound by handrails) or fully enclosed.

Protecting Elevators from Flood Damage

This section provides an overview of measures to protect various elevator components and equipment from flood damage that are common to all elevator systems, and specific steps to protect hydraulic and traction elevators from flood damage in accordance with NFIP regulations.

Elevator Shafts/Enclosures

Elevator shafts enclose the elevator cab and other equipment. Low-rise residential and commercial elevators, particularly those that are added as a post-construction retrofit, are usually installed within a shaft that is independent of an outside wall. Larger elevators are installed within a shaft that is located on the interior of the structure. In either case, the elevator shaft must have a landing, usually at the ground level, and a cab platform near the top. The pits of elevators that have a landing at the lower level are almost always below the BFE.

Since below-BFE elevator shafts/enclosures are not required to include hydrostatic openings or breakaway walls, they may obstruct the flow of floodwaters, and are therefore highly susceptible to damage from various flood forces, including erosion and scour. Therefore, elevator enclosures must be designed to resist hydrodynamic and hydrostatic forces as well as erosion, scour, and waves, particularly in V Zones. This technical bulletin recommends that elevator shafts/enclosures that extend below the BFE be constructed of reinforced masonry block or reinforced concrete walls and located on the landward side of the building to provide increased protection from flood damage. Further, designs for nearby or adjacent structural elements of the building should take into account the impacts of obstructed flow.

In **A Zones**, elevator enclosures are not required to be constructed with hydrostatic openings. However, they must be engineered to resist flood loads (i.e., hydrostatic, hydrodynamic, flood-borne debris, erosion and scour).

In **V Zones**, elevator enclosures are not required to be built using breakaway walls. However, deeper foundations may be needed to account for the increased flood loads (i.e., hydrostatic, hydrodynamic, breaking waves, flood-borne debris, erosion and scour).

Elevator Equipment

Some equipment common to all elevators will be damaged by floodwaters unless protected. The most obvious example is the elevator cab. Depending upon the size of the cab and the types of interior materials used, residential and commercial elevator cabs can be expensive to replace.

Flood damage, which can range from superficial to catastrophic, can be avoided easily by keeping the cab above floodwaters. However, in most elevator control systems, the cab automatically stops upon loss of electrical power, which could be below the BFE during a flood.

Installing a detection system with one or more float switches in the elevator shaft will prevent the elevator cab from descending into floodwaters (Figure 5), providing a much safer system while preventing costly repairs or replacement. A float switch system or another system that provides the same level of safety is necessary for all elevators where there is a potential for the elevator cab to descend below the BFE during a flood.

Where possible, elevator equipment such as electrical controls and hydraulic pumps should be located above the BFE. In some cases, it may be necessary to locate elevator equipment such as switches and controls below the BFE in the **elevator pit**. If equipment must be located below the BFE, it shall be protected using flood damage-resistant components. Flood damage-resistant materials can also be used inside and outside the elevator cab to reduce flood damage (see Technical Bulletin 2, *Flood Damage-Resistant Materials*, for more information).

Electrical equipment is often located below the BFE for both types of elevator systems. Some electrical equipment, such as electrical junction boxes and circuit and control panels, shall be located at or above the BFE as shown in Figure 1. Other elevator components, such as doors and pit switches, may be located below the BFE. Where necessary, components may sometimes be replaced with more flood damage-resistant models. Any electrical equipment installed in the hoistway below the BFE should be National Electrical Manufacturers Association (NEMA) 4 rated enclosure for water resistance. Some elevator equipment manufacturers offer water-resistant components; therefore, design professionals should contact suppliers to determine the availability of these components.

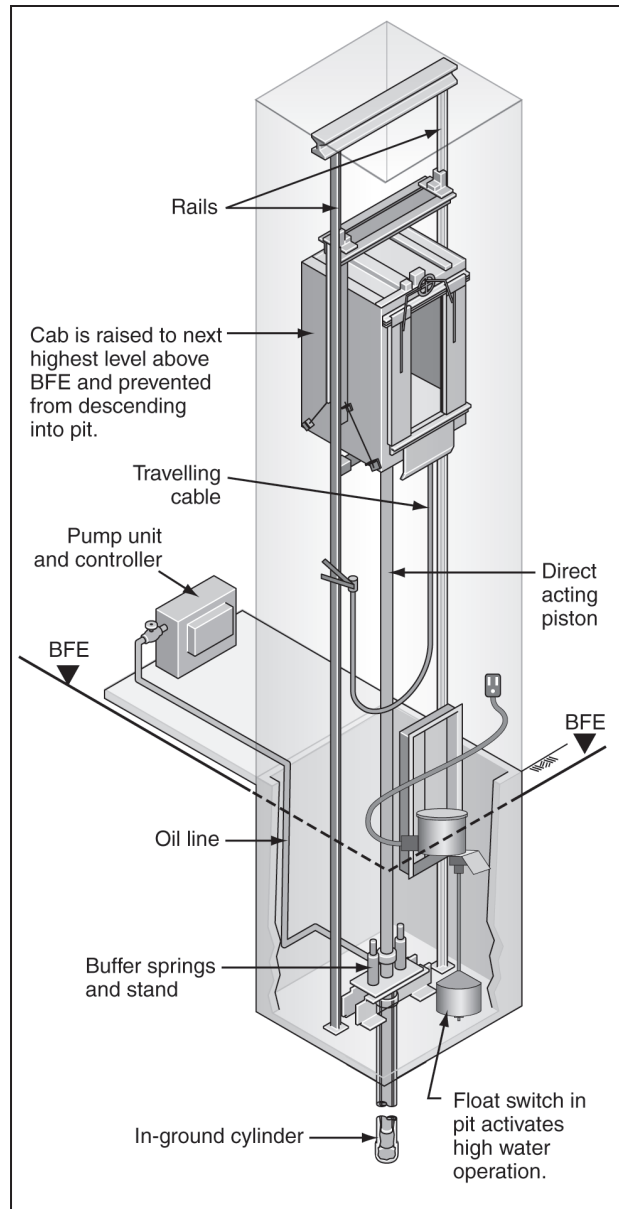


Figure 5. Float Switch to Control Cab Descent
(Source: Otis Elevator Company)

Elevator pit depths typically range between 4 and 5 feet for hydraulic elevators and between 6 and 8 feet for traction elevators. The NFIP does not consider elevator pits to be basements.

Fire Recall Switches and Backup Power

For safety reasons, commercial elevators are designed with “fire recall” circuitry, which sends elevators to a designated floor during a fire so that emergency services personnel can utilize the elevators. However, during flooding, this feature may expose the cab directly to floodwaters. ASME 17.1-2007 requires that, for elevators in flood hazard areas, the designated floor must be located above the BFE. If an elevator is designed to provide access to areas below the BFE, it should be equipped with a float switch system that will activate during a flood and send the elevator cab to a floor above the BFE (Figure 5).

Emergency power circuitry for elevators consists of operation from the emergency generator if installed. In general, when emergency power starts up, all cars will return to the designated floor, and then one will return to normal operation. Emergency power generators are required for elevators of four stories or greater, but are not commonly found in low-rise residential and commercial construction. If there is no emergency power, hydraulic elevators can employ a battery descent feature. Upon power loss, batteries release the hydraulic controls, and the car will descend to the lowest landing above the BFE. If this is employed, care must be taken to integrate the float switch circuitry into the operation of the controller to prevent descent of the car into floodwaters.

If there is no emergency power operation or battery descent, upon loss of power the elevator will cease to function, resulting in possible entrapments or damage. Therefore, it is wise for building owners to leave the elevator cab on an upper floor (above the BFE), and remove power to the elevator machinery before vacating the building before a flood.

Hydraulic Elevators

The jack assembly for a direct acting hydraulic elevator (Figure 1) will, by necessity, be located below the lowest floor and therefore generally below the BFE. The jack is located in a casing that can resist damage from small amounts of water seepage; however, total inundation by floodwaters will usually result in contamination of the hydraulic fluid and possible damage to the cylinders and seals of the jack. Because salt water is corrosive, coastal floodwaters can be particularly damaging. For this reason, when hydraulic elevators are to be used, holeless hydraulics elevators are recommended for use in floodplain areas on structures with two to three floors. Hydraulic jacks can be installed inside the shaft, with the critical seals and components located above BFE as shown in Figure 2. The hydraulic pump and reservoirs of the hydraulic elevator are also susceptible to flood damage. ASCE 24-05 requires that the electrical control panel, hydraulic pump, and tank be located above the DFE. ASCE 24-05 also requires that drainage be provided for the elevator pit. In addition, hydraulic lines connecting the assembly should be located to protect the lines from physical damage. Additional guidance on hydraulic elevator pit mitigation is provided in the text notes on page 11.

Table 1 provides a summary of hydraulic elevator system components, their typical location, and whether they can be protected from flood damage by elevation or replacement with more flood damage-resistant components.

Table 1. Hydraulic Elevator System Components, Locations, and Flood Protection Options

Elevator Component	Typical Component Location	Required Elevation Above BFE?	Replace with Flood Damage-Resistant Component? (Yes/No)
Elevator Shaft (Enclosure)	Entire vertical limit of building	No	Below BFE
Cab	Hoistway	Yes	Yes
Cylinder	Pit	No	No – Use holeless (see note, page 11)
Hydraulic Jack Assembly	Pit	No	No – Use holeless (see note, page 11)
Buffers	Pit	No	No – Paint or coat (see note, page 11)
Machine/Equipment Room	1 st or 2 nd level of building	Yes	Yes
Hydraulic Pump	Above BFE per code	Yes	Yes
Hydraulic Reservoir	Above BFE per code	Yes	Yes
Electrical Control Panel	Above BFE per code	Yes	No

Traction Elevators

The electric motor and most other traction elevator equipment are normally located above the elevator shaft and are therefore not usually susceptible to flood damage (Figure 2). However, some equipment such as the counterweight roller guides, compensation cable assembly, limit switches, selector tapes, governor rope assembly, and oil buffers usually are located at the bottom of the shaft. When this equipment cannot be located above the BFE, it must be constructed using flood damage-resistant materials where possible. Additional guidance on traction elevator pit mitigation is provided in the text notes on page 11.

Table 2 provides a summary of traction elevator system components, their typical location, and whether they can be protected from flood damage by elevation or replacement with more flood damage-resistant components. Note that, while nearly all traction elevator system components can be protected from flood damage, there is little that can be done to protect governor cables other than post-flood replacement (typical cost \$3,000.)

Other Conveyance Mechanisms

As previously stated, pneumatic elevators and chairlifts are usually located inside buildings so all components of these systems can be located above the BFE to protect them from flood damage. Vertical platform lifts (VPLs) may also be placed inside buildings above the BFE to protect them from flood damage. However, for outdoor VPLs placed below the BFE, all equipment that cannot be elevated above the BFE is susceptible to flood damage.

Table 2. Traction Elevator System Components, Locations, and Flood Protection Options

Elevator Component	Typical Component Location	Elevation Above BFE?	Replace with Flood Damage-Resistant Component?
Elevator Shaft (Enclosure)	Entire vertical limit of building	No	Below BFE
Cab	Hoistway	Yes	No
Counterweight and Roller Guides	Hoistway	Yes	No
Hoist Cable	Hoistway	Yes	No
Compensation Cables	Pit	No	Yes
Governor Cable	Pit	No	No
Buffers	Pit	No	No – Paint or coat
Limit Switches	Pit	Yes	No
Machine/Equipment Room (Enclosure)	Top of hoistway	Yes	No – Replace with MRL
Electric Hoist Motor	Above BFE per code	Yes	No
Electrical Control Panel	Above BFE per code	Yes	No

Hydraulic and Traction Elevators Mitigation Guidance

This technical bulletin recommends the following guidance for minimizing damages to hydraulic and traction elevator pits based on a review of elevator damages observed following Hurricane Katrina (2005) and Hurricane Ike (2008).

- **Holeless Hydraulics:** For hydraulic elevators, explore hoistway conditions for the use of holeless hydraulics. Note that holeless hydraulic elevators are only applicable for low-rise construction 2-3 stops.
- **Doors and Door Frames:** Use only stainless steel doors and door frames below the BFE. Recommend grouting in of door frames and sills.
- **Limit Switches:** Relocate switches above the BFE with the use of smaller brackets. Note that modern controllers use selector tapes for landing control systems and require limited length of selector cam for switch activation.
- **Selector Tape:** Use stainless steel selector tape, which can be ordered for most controllers.
- **Slide and Roller Guides:** For hydraulic elevators, use Teflon®-impregnated inserts on slide guides or convert to roller guides to reduce leakage of oil-based products into the pit.
- **Compensation Cables:** For traction elevators, remove compensation cables and replace with encapsulated chain system.
- **Electrical:** Use NEMA 4-rated enclosures, galvanized conduits and watertight conduits and fittings below the BFE. Locate controls and equipment above the BFE whenever possible.
- **Hardware:** Use galvanized sill angles and hardware at floors with elevation below the BFE. Grout sills in full length where applicable.
- **Maintenance:** Paint or coat buffers and all pit steel and hardware with galvanic or rust-preventive paint.

The NFIP

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968. The NFIP is a federal program enabling property owners in participating communities to purchase insurance as protection against flood losses, in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces compliant floodplain management regulations, FEMA will make flood insurance available within the community.

Title 44 of the U.S. Code of Federal Regulations contains the NFIP criteria for floodplain management, including design and construction standards for new and substantially improved buildings located in SFHAs identified on the community's NFIP's flood insurance rate maps. FEMA encourages communities to adopt floodplain management regulations that exceed the minimum NFIP criteria. As an insurance alternative to disaster assistance, the NFIP reduces the escalating costs of repairing damage to buildings and their contents caused by floods.

NFIP Technical Bulletins

This is one of a series of Technical Bulletins that FEMA has produced to provide guidance concerning the building performance requirements of the NFIP. These requirements are contained in Title 44 of the U.S. Code of Federal Regulations at Section 60.3. The bulletins are intended for use by State and local officials responsible for interpreting and enforcing the requirements in their floodplain management regulations and building codes, and by members of the development community, such as design professionals and builders. New bulletins, as well as updates of existing bulletins, are issued periodically, as necessary. The bulletins do not create regulations; rather, they provide specific guidance for complying with the requirements of existing NFIP regulations. Users of the Technical Bulletins who need additional guidance should contact their NFIP State Coordinator or the appropriate FEMA regional office. FEMA's *User's Guide to Technical Bulletins* (<http://www.fema.gov/pdf/fima/guide01.pdf>) lists the bulletins issued to date.

Ordering Technical Bulletins

The quickest and easiest way to acquire copies of FEMA's Technical Bulletins is to download them from the FEMA website (<http://www.fema.gov/plan/prevent/floodplain/techbul.shtm>).

Technical Bulletins also may be ordered free of charge from the FEMA Distribution Center by calling 1-800-480-2520, faxing a request to 1-240-699-0525, Monday through Friday between 8 a.m. and 5 p.m. EST, or e-mailing your request to FEMA-Publications-Warehouse@dhs.gov. Please provide the FEMA publication number, title, and quantity of each publication requested, along with your name, address, zip code, and daytime telephone number.

Further Information

American Society of Civil Engineers, Structural Engineering Institute. 2005. *Flood Resistant Design and Construction*, ASCE/SEI 24-05.

American Society of Civil Engineers, Structural Engineering Institute. 2005. *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7-05.

American Society of Mechanical Engineers and Canadian Standards Association. 2007. *Safety Code for Elevators and Escalators*, ASME A17.1/CSA B44.

FEMA. 1991. *Answers to Questions about Substantially Damaged Buildings*, FEMA 213.

FEMA. 1993. *Non-Residential Floodproofing – Requirements and Certification*, Technical Bulletin 3-93, FIA-TB-3.

FEMA. 1993. *Wet Floodproofing Requirements*, Technical Bulletin 7-93, FIA-TB-7.

FEMA. 1996. *Corrosion Protection for Metal Connectors in Coastal Areas*, Technical Bulletin 8-96, FIA-TB-8.

FEMA. 1999. *Protecting Building Utilities from Flood Damage*, FEMA 348.

FEMA. 2000. *Coastal Construction Manual*, FEMA 55CD (3rd edition).

FEMA. 2005. *Home Builder's Guide to Coastal Construction: Technical Fact Sheet Series*, FEMA 499.

FEMA. 2006. *Mitigation Assessment Team Report: Hurricane Katrina in the Gulf Coast*, FEMA 549.

FEMA. 2007. *National Flood Insurance Program: Flood Insurance Manual*, Revised October 2007.

FEMA. 2008. *Flood Damage-Resistant Materials Requirements*, Technical Bulletin 2, NFIP TB 2.

FEMA. 2008. *Free-of-Obstruction Requirements*, Technical Bulletin 5, NFIP TB 5.

FEMA. 2008. *Design and Construction Guidance for Breakaway Walls*, Technical Bulletin 9, NFIP TB 9.

FEMA. 2009. *Recommended Residential Construction for Coastal Areas: Building on Strong and Safe Foundations*, FEMA 550.

International Code Council, Inc. 2009. *International Building Code*®, IBC® 2009.

International Code Council, Inc. 2009. *International Residential Code*®, IRC® 2009.

International Code Council, Inc. 2009. *International Fuel Gas Code*®.

International Code Council, Inc. 2009. International Mechanical Code®.

International Code Council, Inc. 2009. International Plumbing Code®.

International Code Council, Inc. 2009. International Private Sewage Disposal Code®.

National Fire Protection Association. 2008. National Electrical Code, NFPA 70.

Glossary

Accessory structure – A structure that is on the same parcel of property as a principal structure, the use of which is incidental to the use of the principal structure.

Base flood – The flood having a 1-percent chance of being equaled or exceeded in any given year, commonly referred to as the 1-percent annual chance or “100-year” flood. The base flood is the national standard used by the NFIP and all Federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development.

Base Flood Elevation (BFE) – The height of the base (1-percent annual chance or 100-year) flood in relation to a specified datum, usually the National Geodetic Vertical Datum of 1929 (NGVD), or the North American Vertical Datum of 1988 (NAVD).

Basement – Any area of a building having its floor subgrade (below ground level) on all sides.

Breakaway wall – Defined by the NFIP as “A wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system.” Breakaway walls are used in VI-30, VE, and V zones to enclose parking, building access, and storage areas below buildings.

Coastal High Hazard Area – Defined by the NFIP as “An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources.”

Coastal A Zone – The area of the SFHA that is outside of the V Zone, but inside the LiMWA.

Design Flood Elevation (DFE) – The elevation to which development in the regulatory floodplain is built. The minimum requirement for this elevation in NFIP communities is the BFE. In areas where a higher degree of protection is promoted or required, a freeboard is added; in this case, the DFE is some height (1, 2, or more feet) above the BFE.

Elevation Certificate – A form developed by FEMA to collect surveyed elevations and other information about a building that is necessary to obtain flood insurance.

Enclosure or enclosed area – Areas created by a crawlspace or solid walls that fully enclose areas below the BFE.

Federal Emergency Management Agency (FEMA) – The Federal agency that, in addition to carrying out other activities, administers the National Flood Insurance Program.

Federal Insurance and Mitigation Administration (FIMA) – The component of FEMA directly responsible for administering the flood hazard identification and floodplain management aspects of the NFIP.

Flood Insurance Rate Map (FIRM) – The official map of a community on which FEMA has delineated both the special flood hazard areas (SFHAs) and the risk premium zones applicable to the community.

Hydrodynamic load – The load imposed on an immersed object, such as a foundation element or enclosure wall, by water flowing against and around it. The magnitude of the hydrodynamic load varies as a function of velocity and other factors.

Hydrostatic load – The load imposed on an immersed object such as an enclosure wall, by standing or slowly moving water. The magnitude of the hydrostatic load increases linearly with water depth.

Limit of Moderate Wave Action (LimWA) – The inland limit of the area affected by waves greater than 1.5 feet.

Lowest floor – The lowest floor of the lowest enclosed area of a building, including a basement. Any NFIP-compliant unfinished or flood-resistant enclosure used solely for parking of vehicles, building access, or storage (in an area other than a basement) is not considered a building's lowest floor, provided the enclosure does not render the structure in violation of the applicable design requirements of the NFIP.

Net open area – The permanently open area of a non-engineered opening intended to provide automatic entry and exit of floodwaters.

Opening, engineered – An engineered opening is an opening that is designed and certified by a registered design professional as meeting certain performance characteristics related to providing automatic entry and exit of floodwaters; the certification requirement may be satisfied by an individual certification or issuance of an Evaluation Report by the ICC Evaluation Service, Inc.

Opening, non-engineered – A non-engineered opening is an opening that is used to meet the NFIP's prescriptive requirement of 1 square inch of net open area for every square foot of enclosed area.

Registered Design Professional – An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the State or jurisdiction in which the project is to be constructed.

Special Flood Hazard Area (SFHA) – An area delineated on a FIRM as being subject to inundation by the base flood and designated as Zone A, AE, A1-A30, AR, AO, AH, A99, V, VE, or V1-V30.

Substantial damage – Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred. Structures that are determined to be substantially damaged are considered to be substantial improvements, regardless of the actual repair work performed.

Substantial improvement – Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure (or smaller percentage if established by the community) before the “start of construction” of the improvement. This term includes structures that have incurred “substantial damage,” regardless of the actual repair work performed.

