State of Oregon
Building Codes Division

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Statewide Alternate Method No. OESC 09-01

(Ref.: ORS 455.060)

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Pneumatic Elevators in Residences
Oregon Elevator Specialty Code, ref. ASME A 17.1 Sec. 5.3

Statewide alternate methods are approved by the division administrator in consultation with the appropriate advisory board. The advisory board's review includes technical and scientific facts of the proposal. In addition:

- *Building officials shall approve the use of any material, design or method of construction addressed in a statewide alternate method;*
- *The decision to use a statewide alternate method is at the discretion of the designer; and*
- *Statewide alternate methods do not limit the authority of the building official to consider other proposed alternate methods encompassing the same subject matter.*

Requested by: Gary Miller, National Elevator Contractors, EIA Technologies Inc.

Purpose:
To allow residential installations of pneumatic elevators. To provide that residential pneumatic elevators third-party certified to ASME A17.7 or other internationally recognized standards may be installed in Oregon under this alternate method.

Background:
Currently, there is only one manufacturer of residential pneumatic elevators. Thus, the following description of this technology pertains to the current manufacturer. In the future, other residential pneumatic elevator manufacturers may use a different design. Such designs will be acceptable under this alternate method if they are third-party certified to ASME A17.7 or another internationally recognized standard.

Pneumatic elevators move up and down by changing air pressure, rather than by means of motor driven cables or chains. The elevator car is made of polycarbonate walls and an iron floor and roof. The car runs inside a clear polycarbonate tube. At the top of the tube there are turbines, vacuum valves, and an elevator controller. Elevator operation for an ascent works as follows:

1) A set of turbines begin to exhaust air from above the elevator car, the decrease in pressure above the car causes the car to begin to rise;
2) Two seconds later another set of turbines turn on in order to accelerate the car by increasing the

vacuum pressure;

3) Within 5 cm of the stopping level, a magnetic sensor signals the controller to turn off the second set of turbines, thus slowing the elevator down;
4) When the elevator reaches the desired stopping point, another magnetic sensor signals the first set of turbines to shut down and activates the car locks;
5) When the turbines shut down, the car adjusts to the gravity shift by slowly dropping several centimeters; this drop positions the car snugly on the car locks; and,
6) When the car is anchored on the car locks, a mechanical position sensor opens the doors.

Elevator operation for a descent works as follows:

1) The car locking pins are mechanically released by having the turbines lift the car slightly to trigger a magnetic sensor that releases the locks;
2) The turbines are turned off and vacuum valves are opened allowing air to enter the vacuum chamber causing the car to descend;
3) Within 15 cm of the ground floor, a magnetic sensor signals the vacuum valves to shut off and the elevator slows down to a stop; and,
4) The car anchors onto the car locks which allows a mechanical position sensor to open the elevator doors.

The elevator contains the following safety devices:

- A pressure switch that will not allow car locks to release if there isn't adequate air pressure for an ascent
- Brakes that engage within 2 inches if there is a "free fall"
- If electricity shuts off, the car automatically descends to the ground floor, the car door opens mechanically
- Battery back up for electrical system
- Door safety switches
- Alarm system in elevator car that sounds outside the car at all floor levels
- Emergency ventilation
- Telephone in car

Applicable Code Citation: ASME A17.1 2007 Ref- 5.3 Private Residence Elevators

Technical Discussion:

Under Oregon law, when the division considers making an alternate method ruling on a method of construction, it must consider "standards and interpretations published by the body that promulgates any nationally recognized model code adopted as a specialty code of this state." ORS 455.060.

While 2007 ASME A17.1 has been adopted in Oregon as part of the 2008 Oregon Elevator Specialty Code, there are other national and international standards that can assure elevator safety, such as the 2007 ASME A17.7; European Community Standard, Machinery Directive 98/ 37; or, Canadian Standard CSA B44-94. A code proposal to allow installation of residential pneumatic elevators was submitted to the ASME A 17.1 Residential Code Committee over six years ago. Since that time, as ASME moved forward with adoption of the performance-based 2007 A17.7 Code, the residential committee has not adopted any new amendments. Thus, the residential pneumatic elevator code proposal is still in "pending status." These residential pneumatic elevators are certified by TUV, a German certification that is akin to a UL listing, to the European Community Standard, Machinery Directive 98/37.

Current residential pneumatic elevators also meet all requirements of ASME A17.1 2007 except sections 5.3.1.4.1, 5.3.1.4.2 5.3.1.9.2(b), 5.3.1.12, 5.3.1.16, 5.3.1.17. The intent of these provisions is currently met in the following manner:

Section 5.3.1.4.1- Horizontal Car Clearance between Car and Hoistway Enclosures or Counterweight

There shall be a clearance of not less than 20mm (0.75 in.) between the car and the hoistway enclosure, and between the car and its counterweight.

The clearance required by this rule is designed to protect elevators from damage due to hitting the inside of the hoistway if there is wear in the guides or other equipment. Pneumatic elevators require a 9mm (.354") clearance between the car and the elevator tube in order to maintain airtight seals above and below the car, and to create the vacuum that moves the elevator up and down. The pneumatic elevator car would not move if there was an obstruction on the inside of the elevator tube, thus the elevator could not be damaged and the intent of this rule is satisfied.

Section 5.3.1.4.2- Horizontal Car Clearance Between Car and Landing Sill

The clearance between the car platform and the landing sill shall be not less than 13mm (0.5 in.) no more than 38mm (1.5 in.).

The clearance required by this rule is designed, on the minimum end (13mm), to stop the car and the landing sill from touching due to wear in the guides or other equipment; on the maximum end (38mm) the rule ensures that there is not too big a gap between the car and the exit. Pneumatic elevators require a 9mm (.354") clearance between the car and the elevator tube in order to maintain airtight seals above and below the car, and to create the vacuum that moves the elevator up and down. The pneumatic elevator car would not move if it came substantially into contact with the landing sill, thus the elevator could not be damaged, and the intent of this rule is satisfied.

Section 5.3.1.9.2 (1) Platforms

The platform guard shall have a straight vertical face, extending below the floor surface of the platform not less than the depth of the zone where the hoistway door is unlocked above the landing sill plus 50mm (2 in.). The platform guard shall not strike the pit floor or any obstruction when the elevator is at its lowest point of travel.

This rule protects passengers' toes from being injured should the elevator stop above or below the landing sill. The guard stops the passengers' toes from getting under the sill and possibly injured if the elevator were to move. The pneumatic elevator doors cannot open unless the elevator is sitting on either the ground floor or on retractable metal pins, thus the car must be level with the floor for the doors to open and passenger toes could not be stuck under the landing sill.

5.3.1.12.1 Suspension Means, Types Permitted

(a) Suspension means shall be not less than two wire ropes or two steel roller-type chains conforming to ASME B29.1

The pneumatic elevator uses air pressure as a suspension means. Suspension devices are designed to stop the elevator from freefalling and injuring passengers. The pneumatic elevator has two safety mechanisms that protect from freefall: 1) If there is a sudden loss of power that stops the turbines there are small holes in the elevator car seal that allow the vacuum above the car to slowly decrease and lower the car; 2) There is an emergency brake system that is triggered by decompression due to abnormal air loss. The brake blocks are clamps that affix to the rails to stop the car.

5.3.1.16.2 Driving Machines: General Requirements

The driving means shall be one of the following types:

1) Traction
2) Winding drum
3) Direct plunger hydraulic
4) Roped-hydraulic

5) Screw machine
6) Chain drive
7) Chain-hydraulic
8) Rack-and-pinion, in jurisdictions enforcing NBCC

The pneumatic elevator's "driving means" consists of turbines and valves to control vacuum pressure. The elevator is equipped with five turbo fans and will still function (at slower speeds) with only two fans in operation. If all fans stop working, the vacuum pressure slowly releases and the elevator car descend to the ground floor.

5.3.1.16.2(i) Driving Machines: Manual Operation
Private residence elevators shall be arranged for manual operation in case of power failure. The manual operating device shall conform to the following:
1) It shall not be accessible from inside the car.
2) It shall not release the brake.
3) Upon removal of the device, the car shall not move.
4) It shall be actuated by mechanical means only.
5) Elevators with hydraulic driving machines shall be provided with a manual lowering valve conforming to 3.19.4.4.
6) Instructions shall be posted at or near the manual operating device.

The vacuum pressure within the pneumatic tube functions as manual operation in case of a power failure. When the turbine fans cut off, the vacuum above the car slowly dissipates through small holes in the vacuum seal. This causes the car to descend slowly to the ground floor. When the elevator car rests on the ground floor, the doors open mechanically. The "vacuum pressure" and mechanical door opener safety mechanisms are integral to the functioning of the elevator, thus they cannot be "removed" from the elevator.

5.3.1.17.1 Stopping Devices Required
(a) Upper and lower normal terminal stopping devices operated by the car shall be provided, and shall be set to stop the car at or near the upper and lower terminal landings.
(b) Upper and lower final terminal stopping devices operated by the car to remove power from the motor and the brake shall be provided. They shall be set to stop the car after it travels past the normal terminal stopping device and before an obstruction is struck.

Stopping devices are designed to ensure that an elevator does not go down below the floor landing or above the roof of the top landing. The pneumatic elevator car stops on the floor of the bottom landing, thus it is not possible for the elevator to go past the ground floor landing. There is a rubber buffer pad, in accordance with the code, that would cushion the impact if the elevator was moving at a higher than normal speed. There is also a barrier at the roof of the top landing, which precludes the elevator from going past the roof of the top landing.

Facts:
As approved by the Electrical and Elevator Board, the following technical and scientific facts apply to residential pneumatic elevators:
1) Residential pneumatic elevators move up and down by changing air pressure above and below the elevator car, rather than by means of motor driven cables or chains.
2) Current residential pneumatic elevator technology currently substantially complies with ASME A17.1.
3) The European Community Standard, Machinery Directive 98/ 37 is an internationally recognized standard that applies to residential elevators
4) TUV is a recognized third party certification body.

Scope:
This alternate method addresses residential installation of pneumatic elevators. The acceptability of pneumatic elevators for residential installations is contingent on meeting the following conditions:

1) Except as otherwise provided for in this alternate method, the provisions of the Oregon Elevator Specialty Code shall be applicable to pneumatic elevators installed in residences. The alternate use of Pneumatic elevators in residential structures is in addition to the other requirements of the Elevator Code.
2) Substantial compliance with ASME A17.1; and,
3) Third party certification to ASME A17.7 or another internationally recognized standard.

Conclusion:
After considering the technical and scientific approval by the Oregon State Electrical and Elevator Board, the division rules that pneumatic elevators for residential installation are acceptable as an alternate method, subject to stated limitations, and Alternate Method No. OESC 09-01 is approved.

The recommendation and facts of the Electrical and Electrical Board are accepted and are adopted:

Mark Long, Administrator
Building Codes Division

3/31/2009