Vertical Freight Door Protective Devices

by Henry E. Peelle III, DM

Can the United Parcel Service or Federal Express delivery person operate a freight elevator? Under current ASME A17.1-2007/B44-07 code requirements, the answer is "no." Only the operator and persons authorized to transport freight can ride a freight elevator. Yet, building owners and tenants are increasingly asking if package delivery personnel and over-the-road truckers can operate their freight elevator. To heed this call, substantive changes in door protective requirements will appear in the next addenda to ASME A17.1-2007/B44-07. This update not only improves user safety, but also permits package deliverers, over-the-road truckers and other adult users not part of the general public[1] to operate freight elevators.

This article begins with an overview of existing door protective requirements for vertical freight elevator doors and the changes approved for inclusion in the next addenda to ASME A17.1/B44. The article then turns to detailed discussions of the new requirements and related rationale. Admittedly, these new requirements are complex and technical. Before concluding, the article overviews one approach to compliance and a corollary method of inspection. This approach demonstrates that practical implementation is far simpler than users and regulators might anticipate. The new ASME A17.1/B44 requirements address both vertical counterbalanced bi-parting and vertical slide-up-to-open landing doors. This article will focus on the more prevalent and popular vertical bi-parting landing door coupled with slide-up-to-open counterweighted car gates for freight elevators not intended for general public use.

Current Requirements

Current ASME A17.1-2007/B44-07 requirements for bi-parting landing doors permit simultaneous or sequential closing. During simultaneous operation, the car gate and landing door close together. In contrast, sequence operation requires the car gate to be at least two-thirds closed before the landing door begins to close. Continuous pressure on the closing push button is required for simultaneously closing the car gate and landing doors. Bi-parting landing doors with sequence operation can close by either continuous pressure on the door-close button, by automatic initiation through the operation control or dwell timer, or by momentary pressure on the door close button. Doors closed by automatic or momentary pressure also require a reopening device, advance-of-closing audible warning, limited average closing speed and a door button that, upon initiation, will stop closing, or stop closing and initiate reopening.

Current safety requirements assume the presence of freight operators and freight handlers familiar with the elevator, including door operation. Continuous-pressure close gives the freight-elevator operator control over the initiation, continuation and cancellation of door closing. In sum, continuous-pressure close passes responsibility for safe door closing to the operator. Simply releasing the door close button will initiate door reopening.

For freight elevators with automatic or momentary pressure closing,

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trained freight operators and freight handlers understand the meaning of door close warnings, how to cancel door close and how to initiate reopening. Sequence operation blocks egress and warns of pending landing door closure by placing an obstruction (i.e., the car gate) into the entrance path before closing the bi-parting landing door. Contact-type reversal devices mounted on the leading edge of the car gate stop and initiate reopening should the closing car gate encounter an obstruction. While code-mandated limits on average closing speed mitigate, in part, the level of imparted kinetic energy caused by impact, the current code permits the obstruction to experience the full kinetic energy of the closing car gate before initiating reversal[2].

New Requirements for Freight Elevator Door Object Detection

In the new code requirements, the sign limiting freight elevators to operators and freight handlers will now read, "THIS IS A FREIGHT ELEVATOR, NOT A PASSENGER ELEVATOR, AND NOT FOR GENERAL PUBLIC USE" [Public Review Draft November 2007, A17.1a-200x, Addenda to A17.1-2007, Requirement 2.16.5.1.2, Capital letters in the original][3]. This altered signage permits use by the non-trained adult user. However, this requirement still prohibits use of freight elevators by the general public. These new requirements open freight-elevator use to package delivery personnel and other non-employee freight handlers, while excluding the general building tenant, visitor, passersby, child or other members of the public.

The new ASME A17.1/B44 door protective requirements remove the assumption of a vigilant and aware freight elevator operator. Unlike trained operators, package delivery persons might have limited understanding of freight elevator operation and functionality. Package delivery persons might not attend to persons entering or leaving the freight elevator when he or she is closing the doors. Package delivery personnel might not understand the meaning of advance-of-door-close warning, nor, in high ambient noise environments, hear such warnings. Package delivery persons might be unaware that action on the door push buttons can initiate reopening. Moreover, package delivery personnel might not react with sufficient speed, even if aware of persons within the opening, while door closing is in process.

In sum, extending usage of freight elevators to package delivery personnel limits the effectiveness of many traditional safety devices employed on freight elevators, such as continuous pressure close and advance-of-close warnings. Moreover, current code requirements permitting contact-type reopening devices leave the unaware and untrained user vulnerable to the full kinetic energy of the closing car gate.

To mitigate the risk of potential injury to this broadened base of users, new requirements add detection devices able to sense the presence of an adult user within or immediately adjacent to the closing car gate, without regard to the location of the door or gate. Once the user enters the plane of the car gate, detection devices prevent closing or initiates reversal to open, if closing is underway. Reversal becomes independent of the actions or awareness of the user, rendering moot operator knowledge of the system and reaction time.

The new code requirements, by creating zones of detection independent of the door or gate leading edge, also reduce the probability of incidental contact resulting from travel inertia. A moving system with mass cannot stop instantaneously. Initiation of reversal of a closing door or gate will cause the motor operators to reverse direction and impose braking. Factors such as gate mass and speed, electro-motive forces, friction and electrical device response time impose a delay between initiation of reversal and actual physical reversal of the door or gate to the open direction.

In current requirements, initiation to open may commence when the reversing device physically contacts the obstruction. These devices are typically mechanical and require the force of contact to signal the presence of an obstruction. Reversal systems employing a single infrared beam located just below the leading edge of the car gate eliminate the necessity for physical contact to initiate reversal. However, even this arrangement holds a probability that inertia of the closing car gate will carry the car gate leading edge into the obstruction located just below the leading edge, albeit at a much lower level of kinetic energy.

In contrast, new code requirements impose immediate initiation of reversal to the open direction as soon as a person places his or her body part in a zone of detection, regardless of the relative location of the body part to the door or gate. Entry of a body part into the detection zone will prevent the fully open door or gate from closing or initiate reversal to open if the car gate is closing. A person placing his or her head into a detection zone will initiate reversal of a closing landing door or car gate, even if the leading edge of the door or gate is at a distance well above that person's head.

While these new requirements do not eliminate the potential of incidental contact caused by inertia, incidental contact will only result if the person intentionally places his or her body in a position immediately adjacent to the leading edge of an already closing car gate. No longer will the reversal system wait until the leading edge approaches or makes contact with the obstruction. Instead, reversal to open will occur upon detection of an object in the detection zone, regardless of door or gate location.

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With impact mitigation dependent on detection devices, new code requirements incorporate detection device function checking prior to closing. Should function testing fail, the landing door and car gate will not close. During each open-close cycle, function testing validates wiring between the light curtain and the operational control, light-curtain output relay, light-curtain internal control and light-curtain transmitting and receiving elements. If testing demonstrates that wiring and light-curtain device components are functioning, the landing door and car gate can close when initiated by push button or automatic means.

With the exception of Firefighters' Emergency Operation, these new code requirements prohibit simultaneous landing door and car gate operation. Freight elevators with vertical bi-parting doors must include sequence operation for momentary pressure and automatic closing, as well as for continuous pressure closing. Since sequence operation clears the entrance before permitting the landing doors to close, sequence operation allows obstruction detection to be limited to the car gate. During sequence closing, a closing car gate requires users to be out of the path of the closing gate. Inside the car, the now closed car gate blocks users from incidental contact with the landing door. At the landing, the action of the closing car gate plus a rising lower bi-parting door panel moves users away from the entrance and warns that bi-parting doors are closing.

As landing door bi-parting panels approach full close, the new requirements mandate a further reduction in door-closing speed. This requirement is in addition to the currently required leading-edge landing-door astragal and the limitation on average closing speed. While unlikely that a user would rest an arm or head on approaching meeting edges of closing bi-parting door panels, reduced closing-speed provides the user with additional time to react. Yellow and black diagonally striped warnings placed along the leading edge of the lowermost landing-door panel warn users not to insert parts of their body between closing landing-door panels. Finally, if the user needs to reverse the landing door, momentary pressure on the code-required in-car and landing-door open button will initiate a reversal to open of a distance sufficient to remove an arm, leg, hand or head.

The new requirements also recognize freight elevator applications that render detection devices ineffective or impractical, such as environments with high levels of particulates or applications with extreme opening widths. For these conditions, bi-parting freight landing doors and car gates must operate using continuous-pressure close, incorporate further reductions in average closing speed and limit usage strictly to authorized users. The following table provides a comparison of current and new requirements for freight elevators with bi-parting landing doors.

Detection Zones

The new requirements describe object sizes and detection zones, instead of proscribing the characteristics of the detection device. While this approach added considerable complexity to the new requirements, proscriptive requirements based around particular devices can chill future innovation. In contrast, requirements proscribing what, when and where, instead of how, offer greater long-term adaptability to new approaches without compromising safety or necessitating code requirement rewrites. Even so, a sample from the resulting requirements illustrates the resulting complexity [Public Review Draft, November 2007, A17.1a-200x, Addenda to A17.1-2007, Requirement 2.13.3.4.7(d)][3]:

Device(s) shall be provided that detect an object in the shape of a rectangular prism measuring 170 mm (6.75 in.) high, with a base 140 mm (5.5 in.) wide and 140 mm (5.5 in.) deep, oriented with the base parallel to the floor and the width parallel to the face of the door, in the following locations:

(1) Anywhere within the opening width of the car door or gate when located immediately adjacent to the vertical plane established by the landing side of the car door or gate and where the object is located wholly within a vertical zone extending from the car floor to a horizontal plane at:

(a) 1880 mm (74 in.) above the floor; or

(b) The leading edge of the door if the leading edge is less than 1880 mm (74 in.) above the floor

(2) Anywhere within the opening width of the car door or gate when located immediately adjacent to the vertical plane established by the car side of the car door or gate and where the object is located wholly within a vertical zone extending from the car floor to a horizontal plane at:

(a) 1880 mm (74 in.) above the floor; or

(b) The leading edge of the door if the leading edge is less than 1880 mm (74 in.) above the floor

Development of these new zone-of-detection code requirements drew upon analyses of hypothetical persons moving into, through and out of the opening. These analyses indicated that persons could be located at the outside edge of the car gate with his or her back or front to the car gate, and subject to sideswiping. Persons could be located directly in the path of the closing car gate. Persons could be standing upright, standing in a downward bowed position with head pointed toward the floor, seated in a vehicle, squatting or lying prone across the path of the car gate. Developers of the new code requirements optimized the number of and size of zones to

Summary of existing and new code requirements

	Current ASME A17.1-2007/B44-07			New ASME A17.1/B44 Requirements
Requirements	**Bi-Parting** **Momentary Pressure Operation**	**Bi-Parting** **Continuous Pressure Operation**		**Bi-Parting** **Momentary and Continuous Pressure Operation**
Operating Modes				
Sequence Operation	Required (2.13.3.4.2)	Not Required		Required (2.13.3.4.7a)
Reopening by Push Buttons				
Release of Close Button Reopens Door	Not Required	Required (2.13.3.2.1)		Required for Continuous Pressure Close (2.13.3.2.1) Not Required for Momentary Pressure Close
Momentary Pressure Button to Initiate Reopening	Required in the Car and at Each Landing (2.13.3.4.4)	Not Required		Required in the Car and at Each Landing (2.13.3.4.3)
Warnings				
Warning Bell	Required (2.13.3.4.1)	Not Required		Not Required
Warning Strip	Not Required	Not Required		Required on each Landing Door (2.13.3.4.7c)
Speed Limitations				
Limit on Average Closing Speed/Kinetic Energy	Limitation on Average Closing Speed of Car and Landing Door (2.13.3.4.5)	Not Required		Limitation on Average Closing Speed of Car and Landing Door (2.13.3.4.4)
Limit on Speed/Kinetic Energy Just Prior to Full Close	Not Required	Not Required		Limitation on Maximum Speed of Landing Door Prior to Closing (2.13.3.4.7b)

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Summary of existing and new code requirements

	Current ASME A17.1-2007/B44-07			New ASME A17.1/B44 Requirements
Requirements	**Bi-Parting Momentary Pressure Operation**	**Bi-Parting Continuous Pressure Operation**		**Bi-Parting Momentary and Continuous Pressure Operation**
Reopening Device				
Where Located	Required on or at Car Door Only When Kinetic Energy Exceeds 3.5J (2.13.3.4.3)	Not Required		Required on or at Car Door (2.13.3.4.7)
Detection Zone	Respond to Any Obstruction Within the Width of the Opening (2.13.5)			Detect Objects Immediately Adjacent to Landing Side of Door or Adjacent to Car Side of Door (2.13.3.4.7d) Detect Objects within Path of Door (2.13.3.4.7e) Detect/Mitigate Objects on Floor in Path of Door (2.13.3.4.7f) Detect Objects Straddling Bi-Parting Door (2.13.3.4.7g)
Physical Contact Permitted to Initiate Reopening	Yes (2.13.5)			No (2.13.3.4.8)
Object Detection Device Function Checking	Not Required			Yes (2.13.3.4.9)

provide detection of the adult person located in any of these locations and body positions, or alternately, offering a means to mitigate associated hazards.

For example, the above requirement 2.13.3.4.7(d) describes the parameters necessary to detect an object equivalent to the head of a small adult (and other larger body parts) located anywhere between the floor to a vertical height equal to that of a standing large adult. The detection zone requires detection of this object if located immediately adjacent to the path of the car gate, both on the car and landing side. Body size dimensions were from ISO 3411-1995(E) and SAE J833 standards. Figure 1 depicts a head-sized object located within the required detection zone that is adjacent to and potentially subject to contact by the closing car gate.

Code parameters also require detection of the person when located directly in the path of the closing car gate. Detection occurs by sensing the torso in zones ranging from a squatted or seated position to full standing height for both a small and large adult. When the thickness of the car gate is less than 210 millimeters (8.25 inches), equal to the torso depth dimension of a small adult,

detection devices that sense objects immediately adjacent to either side of the car gate might also detect the presence of the person directly in the path of the car gate. Entry into a position directly in the path of the car gate requires first passing through detection zones located immediately adjacent to the path of the car gate, thus preventing closure or initiating reversal. Obviously, a body part, such as the head or torso extending outside the vertical path of the car gate, enters into the detection zones located immediately adjacent to the path of the car gate. Figure 2 depicts a torso-sized object located within the path of the car gate with a car gate of a width less than 210 millimeters and of a width greater that 210 millimeters. Figure 2 places the torso-sized object relative to the required zones of detection for persons adjacent to the car gate for each of the two car gate widths.

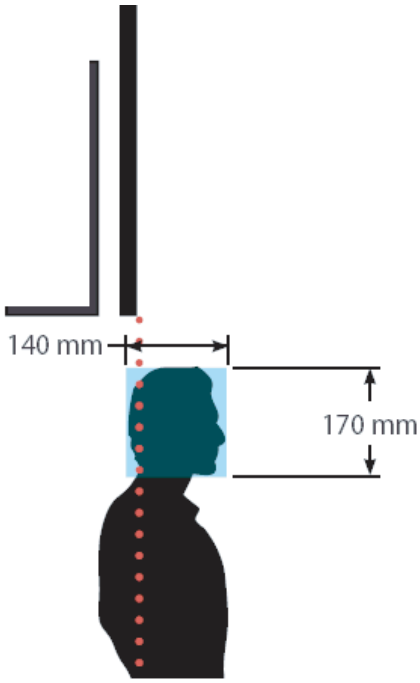

Figure 1: Person standing adjacent to car gate

On vertical slide-up-to-open car gates, detecting an extended arm, leg, or hand will occur by:

1. Detection of the person's head, trunk or legs as they stand immediately adjacent to the path of the car gate as he or she extends his or her arm, leg or hand into the path of the car gate;
2. Entry of the leg, arm or hand into the vertical plane immediately adjacent to the path of the car gate, if entry coincides with the detection zone; or by
3. Downward rotation of the extended leg, arm or hand as the leading edge of the closing car gate moves the leg, arm or hand across a detection zone or, alternatively, out of the path of the closing car gate.

Figure 3 illustrates a person with arm extended into the path of the car gate, the range of motion of the arm as it moves downward and the location of the arm relative to required detection zones.

The new requirements require detection of a foot-sized object located on the floor adjacent to the path

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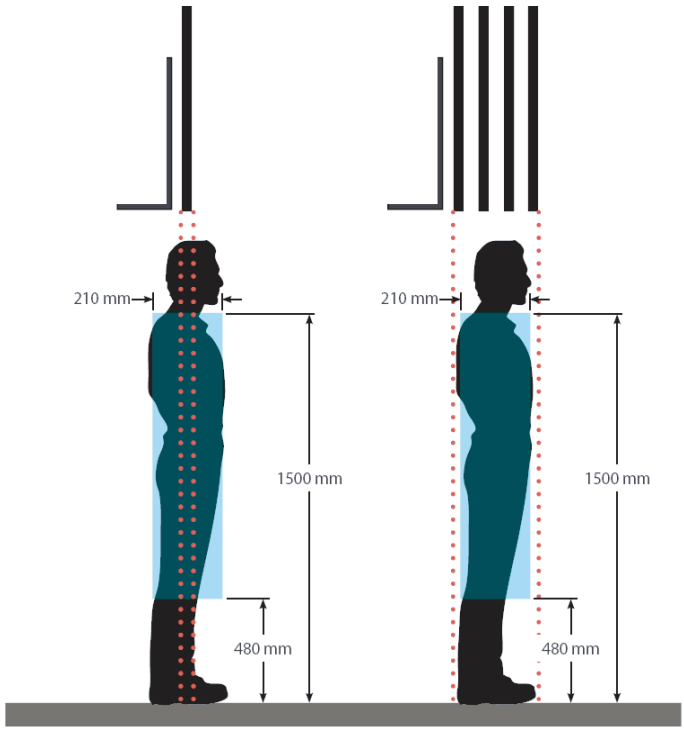

Figure 2: Person standing in path of car gate

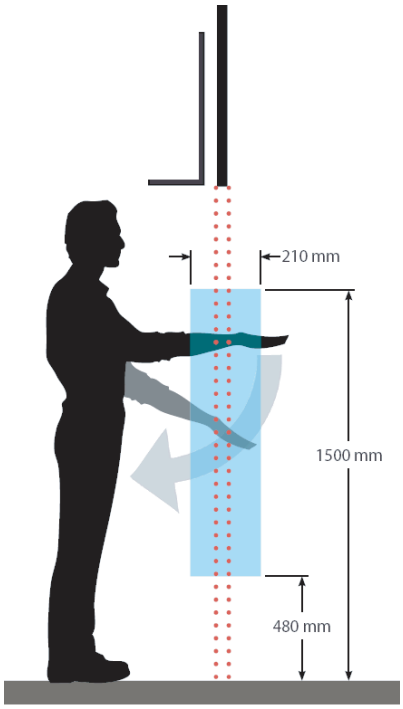

Figure 3: Person standing adjacent to car gate with arm extended

of the closing car gate on either the car side or landing side. In lieu of detection, designers can opt to provide a cushioned member incorporating stops holding rigid members apart by 50 millimeters (2 inches), a distance sufficient to extract an entrapped foot. Finally, the new requirements require detection of a foot-sized object should sufficient space exist between the edge of the closed car gate and the car side of the landing door sufficient to allow an adult to straddle the truck-able sill of the lower bi-parting landing door panel. Figure 4 illustrates a foot straddling the landing door alone, and a foot both straddling and in the path of the closing car gate. While designers have the option of detection or the cushioned edge to mitigate car gate impact on the foot, both cases in Figure 4 require detection of the foot on the platform.

One Approach to Compliance

Detection Devices

As complex as the new requirements appear, compliance can be implemented using devices readily available in today's marketplace. One approach places commercially available light curtains of a type used on passenger

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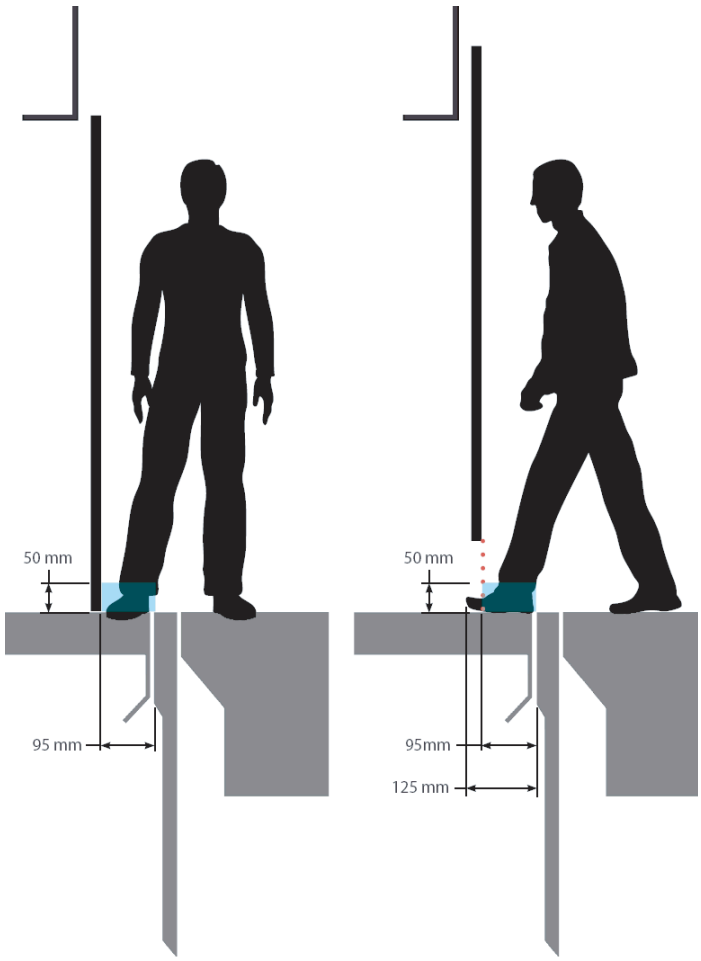

Figure 4: Person with foot adjacent to car gate and straddling the lower bi-parting panel

elevators, on either side of the car gate. The manufacturer may modify the light curtains to retain affectivity over the large opening width typical of a freight elevator. In sum, two light-curtain sets, one set mounted between the car gate rail and the car enclosure return on the car side, and one set mounted on the car gate rail in the space between car and landing doors, can provide object detection sufficient to meet the new code requirements. Figure 5 illustrates such an arrangement.

Commercially available light curtains provide detection of objects of any width within a zone ranging from 25 millimeters above the floor to 1,788 millimeters above the floor. Most light curtain detection zones are more than sufficient to detect a 170-millimeter high object wholly within a vertical zone ranging from the floor to 1,880 millimeters above the floor, or an object on the floor of 50 millimeters in height or greater. Moreover, there is no need for additional detection elements to sense objects in the direct path of the car gate when the distance between detection zones for light curtains mounted on the landing side of the car gate and on the car side of the car gate is less than 210 millimeters.

Inspection

Inspection personnel can attest to code compliance of the above-described approach by measuring the vertical gap between beams for each light curtain set, along with measuring the location of the lowermost and uppermost beams (see Figure 6). A beam is the path of infrared light emanating from each light-emitting diode located on the transmitter and traveling across the width of the opening to the receiver, which when interrupted, signals the presence of an obstruction. The vertical gap between beams for light curtains mounted adjacent to the car gate should not exceed 170 millimeters [New Requirement 2.13.3.4.7(d)]. To provide foot-straddling protection and detection of a person lying prone, the lowermost beam for each light curtain set should be no more than 50 millimeters from the floor [New Requirements 2.13.3.4.7(f) and (g)].

In the described arrangement, the uppermost beam detects the head of a standing adult. According to ISO 3411:1995(E), the top of the head of a large adult is 1,880 millimeters from the floor. While ISO 3411:1995(E) finds the head height of a large adult (205 millimeters) to be greater than that of a small adult (170 millimeters),

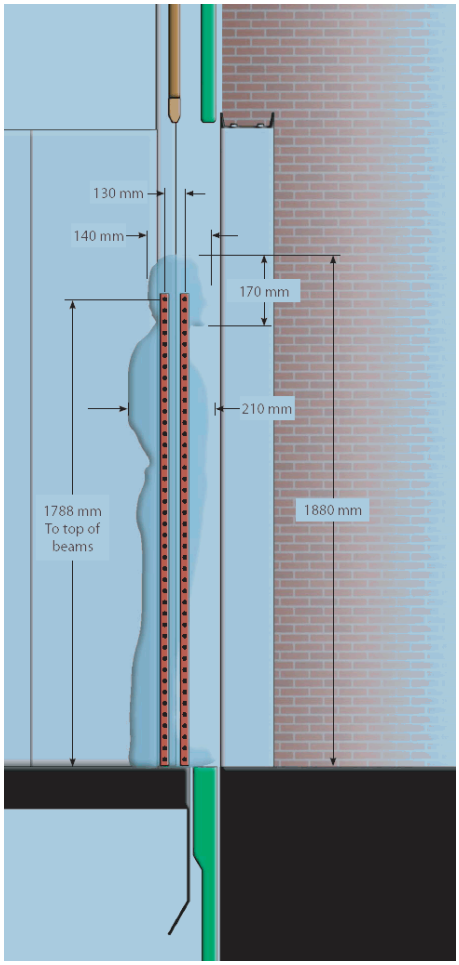

Figure 5: Depiction of one possible arrangement using light curtains

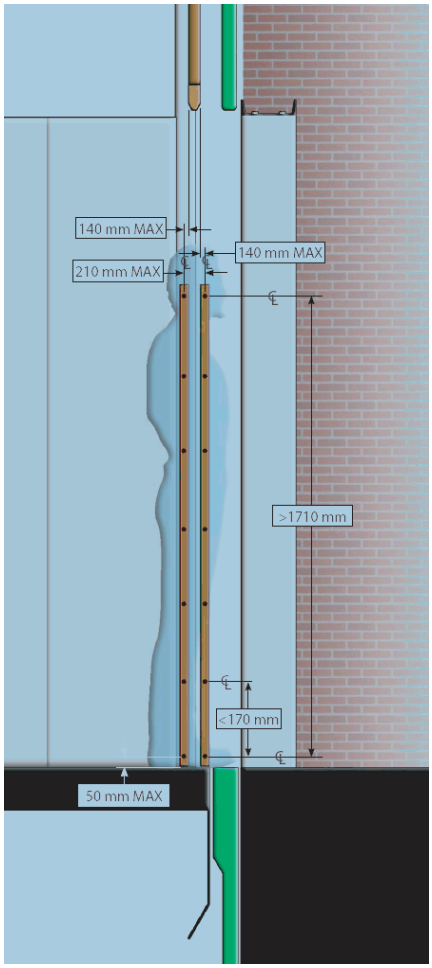

Figure 6: Inspection of light curtains for dimensional compliance

the head height of a small adult determined the code required 170 millimeters vertical detection spacing [New Requirements 2.13.3.4.7 (d)(1) and (2)]. Compliance with new requirements 2.13.3.4.7 (d)(1) and (2) would occur if the uppermost beam is vertically located between 1,710 and 1,880 millimeters above the floor. The 1,710-millimeter dimension derives from the vertical distance to the top of the head of a standing large adult (1,880 millimeters) minus the code-required vertical detection spacing of 170 millimeters.

Inspection personnel can test for adjacency protection of the above-described approach by measuring the horizontal distance between beams for each set of light curtains and the outermost edge of the car-gate panel (see Figure 6). A measured distance of less than 140 millimeters indicates compliance [New Requirement 2.13.3.4.7 (d)]. When the horizontal distance between the beams of the light curtain mounted on the landing side of the car gate and the light curtain located on the car side of the car gate is less than 210 millimeters, then beams providing adjacency detection will also detect required objects located within the path of the car gate [New Requirement 2.13.3.4.7 (e)].

Mitigating foot impact under the closing car gate requires either detection or a cushioned leading car-gate edge [New Requirement 2.13.3.4.7 (f)]. Assessing the presence of the cushioned edge is a simple matter (see Figure 7). Inspectors can verify detection compliance by measuring the horizontal distance from the lowermost beam to the edge of the car gate, and the vertical distance between the lowermost beam and the car or landing platform (see Figure 8). In the former, the measured dimension must be less than 125 millimeters. For the latter, the measured distance for the lowermost beam must be at 50 millimeters or less above the floor.

Finally, there is no need for foot straddling protection [New Requirement 2.13.3.4.7 (g)] if the distance between the landing side of the closed landing-door panel and the car side of the landing-door truck-able sill is equal to or exceeds 95 millimeters, when measured 50 millimeters above the car floor (see Figure 9). If the dimension exceeds 95 millimeters, which provides sufficient space for placement of a foot, compliance requires the vertical dimension of the lowermost beam of the light curtain located between the car and landing door to be 50 millimeters or less from the car sill, and the following:

1. The horizontal distance between the lowermost beam of the light curtain must be less than 95 mm from edge the closed car door panel; and
2. The horizontal distance between the lowermost beam of the light curtain must be less than 95 mm from car side edge the landing door truck-able sill, when the door is fully open.

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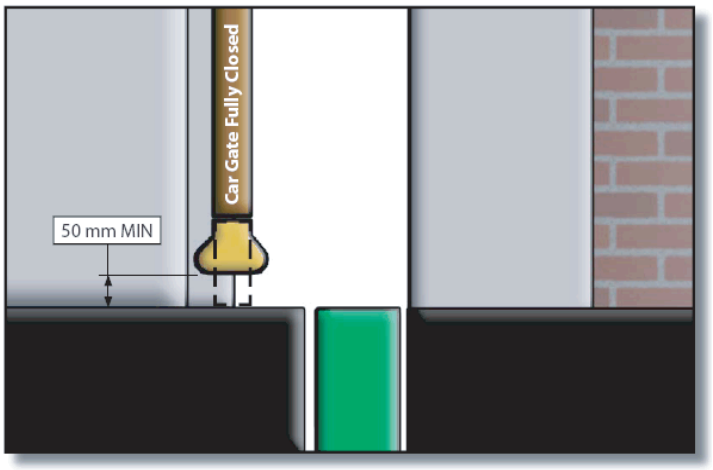

Figure 7: Inspection of cushioned edge for compressed clearance compliance

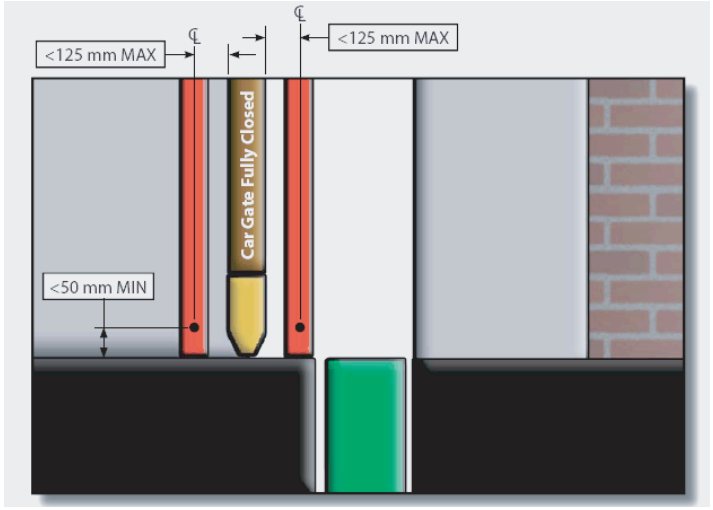

Figure 8: Inspection of lowermost beam for foot protection compliance

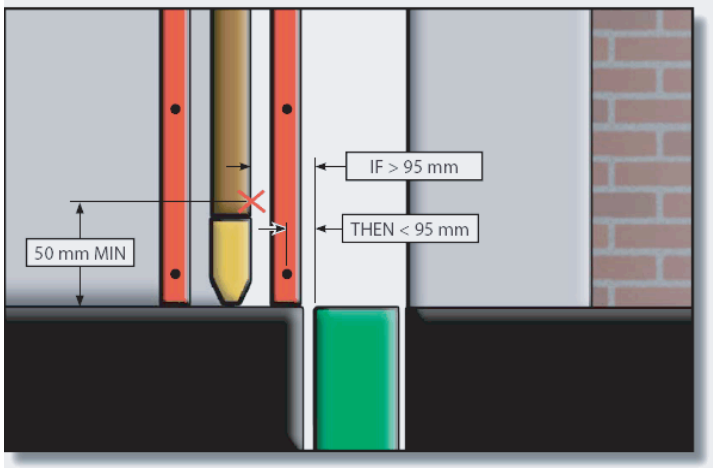

Figure 9: Inspection of dimensionality requirements for straddling protection compliance

Detection Device Function Testing

The new requirements mandate light curtain function testing prior to door close. The requirement is as follows [Public Review Draft, November 2007, A17.1a-200x, Addenda to A17.1-2007, Requirement 2.13.3.4.9][3]:

> *After the door has reached its fully opened position and before door closing is initiated, the detection means used to comply with 2.13.3.4.5(a), (b) or (c), 2.13.3.4.6(c), (d) or (e), or 2.13.3.4.7(d), (e), (f) or (g), where applicable, shall be checked to assure that the device is capable of sensing the defined objects and the appropriate signal is sent to the operation control (see 1.3). If the device is incapable of sensing the defined object or sending the appropriate signal, power closing of the door(s) or gates(s) shall be rendered inoperative.*

In this requirement, vertical-door protective devices must demonstrate their capability to sense objects and send requisite signals to the operation control before the operation control can authorize door closure. This section provides an operational overview of typical light-curtain designs, an approach to field testing during installation and routine maintenance, and a description of one approach to function testing.

Light Curtain Operational Overview

Contemporary light curtains consist of light-emitting diodes (TX), light-receiving elements (RX) and a light-curtain operational control. Light curtains operate by sequentially activating each TX, typically beginning with the topmost TX and progressing downward in turn. The infrared signal from each TX activates one or more RX element. Activated RX elements are a conduit that convert infrared light into electrical signals, which are then transmitted to the light-curtain control. Time for a complete scan from the uppermost to lowermost TX typically occurs within milliseconds.

The light-curtain control receives and, in some cases, measures the electrical signal pattern received from activated RX. Depending upon the electrical signals received or not received, the light-curtain control sends an output signal indicating the presence or absence of an obstruction. The scanning process is continuous. With each completed scan the light curtain updates and signals if an obstruction is present or the path is clear.

Some light-curtain designs couple a specific TX to a specific RX. Upon activating a TX, the light-curtain control system looks for a signal from that specific RX. This type of arrangement verifies that individual TXs emit infrared signals and individual RXs receive signals. Failure of a TX to emit a signal or the corollary RX to receive the signal, toggles the light-curtain control to indicate the presence of an obstruction. Other light curtain designs look for an RX output matching a particular electrical signal pattern associated with the infrared source from the TX. Unless the RX output matches the particular electrical signal pattern anticipated by the light-curtain control unit, the control system sets the output relay to indicate the presence of an obstruction.

Field Testing

Manufacturers test light curtains for component integrity, short circuits and function prior to shipment. Manufacturers typically recommend testing at initial installation and during routine maintenance. Typical jobsite testing begins by moving an opaque piece of material of a height equal to the target object size down the full length of the light curtain at or near the center of the opening. An opaque material of 170 millimeters would suffice for light curtains located on the car side and landing side of the car gate (see Figures 5 and 6). As the opaque test material moves downward, the light-curtain control should continuously signal the presence of an obstruction. A second piece of opaque material, 50 millimeters high, would test the lowermost TX and RX elements.

Function Testing

The purpose of function testing is to test for a properly operating light curtain. Function testing verifies an operational obstruction/non-obstruction indicating output relay, transmission of signals from the light curtain output relay to the operation control (and thus verifying wiring connections from the light curtain output relay to the operation controller), and for functioning light curtain system components (TX, RX, light-curtain control).

One method of function testing employs a test input. The test input is used to trigger a function test of the light curtain prior to door closing. The test input function check (TIFC) begins when the car and landing doors are in the fully open position and the light curtain is unobstructed (light-curtain output relay ON). The operation control will not initiate TIFC until the light-curtain output relay indicates no obstructions present. The operation control initiates TIFC by toggling the light curtain test input from ON to OFF. When the test input transitions to OFF, the light curtain performs internal integrity checks of TX and RX elements along with the internal microprocessor and light-curtain control. The output relay, with a short delay, follows the transition of the test input by changing state from ON to OFF. Once the operation control determines that the output relay has changed state from ON to OFF, it signals the light curtain test input to transition from OFF to ON.

Function testing concludes when the operation control receives an 3(before toggling the test input from ON to

OFF) to OFF (after toggling the test input from ON to OFF) and back to ON, verifies a light curtain output relay capable of changing state and able to transmit signals from the light-curtain control to the operation control. Failure of the operation control to receive an ON signal from the light curtain output relay, following the operation control's toggling of the test input from ON to OFF, will disable door closing and re-initiate TIFC. Since a person passing through the open entrance during function testing will cause a TIFC failure, re-initiating TIFC can eliminate unnecessary shutdowns.

In sum, the described system provides a means to function test once the doors reach full open and to prevent initiation of close by automatic means or by push button if function testing fails. The test input function test verifies that the light curtain is capable of operating properly, including light-curtain control, transmitter (TX), and receiving (RX) elements. Operation control measurement of the changing state of the light curtain output relay during function testing verifies a functioning light curtain output relay, electrical connections between the operation control and the light-curtain output relay, and power to the light curtain transmitter, receiver and control unit.

Conclusion

This article reviewed new requirements for vertical doors included in the pending addenda to *ASME A17.1-2007/B44-07 Safety Code for Elevators and Escalators.* The changes address the chorus of demand to permit package delivery personnel and off-road truckers to use freight elevators. Replacing vigilant and trained elevator operators with users of limited knowledge required code writers to include object-detection devices capable of responding to obstructions independent of the action of the user.

While the resulting requirements are complex, this article demonstrates that compliance is obtainable with simple design configurations using commercially available components. Moreover, inspection is not as difficult as the requirements might otherwise suggest. The result is an important and much needed update to vertical door safety requirements suited to a user group needing independent access to freight elevators.

Footnotes

1) The general public are members of society who have no specialized role or task to fulfill in a specific area. Access to those specific areas is typically restricted.
2) All major manufacturers of freight-elevator doors offer non-contact reopening device to replace or supplement contact-type reversing edges. These devices provide non-contact initiation of reversal. However, because of residual kinetic energy of a closing car door or gate, none of the devices can guarantee that incidental contact between the car door/gate and the obstruction will not occur.
3) From Public Review Draft: Proposed Revisions for ASME A17.1a-200x ADDENDA To *ASME A17.1-2007, Safety Code for Elevators and Escalators*. These are draft rules that are subject to change. All rights reserved. Reprinted with the permission of the American Society of Mechanical Engineers, New York, NY.

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