United States
CONSUMER PRODUCT SAFETY COMMISSION
4330 East West Highway
Bethesda, MD 20814

This document has been electronically approved and signed.

BALLOT VOTE SHEET **DATE:** March 15, 2017

TO: The Commission
Todd A. Stevenson, Secretary

THROUGH: Mary T. Boyle, General Counsel
Patricia H. Adkins, Executive Director

FROM: Patricia M. Pollitzer, Assistant General Counsel
Hyun S. Kim, Attorney

SUBJECT: Petition Requesting Rulemaking on Residential Elevators

BALLOT VOTE DUE: Tuesday, March 21, 2017

On November 13, 2014, The Safety Institute, Carol Pollack-Nelson, and Cash, Krugler & Fredericks, LLC, requested that the Commission issue a safety standard for residential elevators to address an entrapment hazard between the elevator car door and hoistway door. On January 7, 2015, the Office of the General Counsel docketed the request as a petition under the Consumer Product Safety Act (CPSA), Petition CP 15-1. Notice of the petition was published in the *Federal Register* on January 22, 2015. In the attached briefing package, staff recommends that the Commission deny the petition.

Please indicate your vote below:

I. Grant the petition and direct staff to begin developing a notice of proposed rulemaking.

_____ _____
(Signature) (Date)

II. Defer the petition.

_____ _____
(Signature) (Date)

III. Deny the petition and direct staff to draft a letter of denial to the petitioner.

_____ _____
(Signature) (Date)

IV. Take other action (please specify).

_____

_____

_____

_____ _____
(Signature) (Date)

Attachment: Staff briefing package: staff recommendations to the Commission on Petition CP 15-1, Petition for Residential Elevators

BRIEFING PACKAGE

PETITION CP 15-01:
PETITION FOR RESIDENTIAL ELEVATORS

March 15, 2017

For additional information contact:

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Table of Contents

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

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Memorandum

Date: March 15, 2017

TO : The Commission
Todd Stevenson, Secretary

THROUGH: Patricia H. Adkins, Executive Director
Mary T. Boyle, General Council

FROM : George A. Borlase, Ph.D., P.E., Assistant Executive Director
Office of Hazard Identification and Reduction

Vincent J. Amodeo, Project Manager
Directorate for Engineering Sciences

SUBJECT : Staff Recommendation to the Commission on Petition CP 15-1 Requesting Rulemaking on Residential Elevators

I. Introduction

On November 13, 2014, The Safety Institute, Carol Pollack-Nelson, and Cash, Krugler & Fredericks (petitioners) petitioned the U.S. Consumer Product Safety Commission (CPSC, or Commission) to initiate mandatory rulemaking to set safety standards for residential elevators to eliminate excessive space between the elevator car door/gate (car door) and the hoistway or swing door (hoistway door) (TAB A). The petitioners requested that the rule constrain the space between the car door and hoistway door to no more than 4 inches when measured from the inside of the hoistway door to the farthest point on the car door. On January 22, 2015, the CPSC's Office of the General Counsel docketed the request for rulemaking as Petition CP 15-1 (80 FR 3226) under the Consumer Product Safety Act (CPSA).

CPSC staff prepared this briefing package for the Commission to consider Petition CP 15-1 *Petition Requesting Rulemaking on Residential Elevators*.

II. Discussion

a. Petitioners' Request

The petitioners state that the space between the elevator car door and hoistway door in many residential home elevators, and similar elevators found in apartment and commercial buildings, is large enough to allow children up to 12 years of age to fully fit between the closed doors. If the child becomes trapped in the space when the elevator is called to another floor, the child is dragged inside the hoistway until the child's body is crushed against the next floor's sill.

The petitioners state that the applicable voluntary standard, American Society of Mechanical Engineers (ASME) A17.1-2013, *Safety Code for Elevators and Escalators*, allows a gap of up to 5 inches between the residential elevator car door and hoistway door, which fails to safeguard children from injuries and deaths from elevator entrapment.

According to the petitioners, in 1931, Otis Elevator Company (Otis) obtained a patent for an inexpensive 6-inch space guard to prevent child entrapment, and in 1932, Otis sent a letter to its customers warning of the hazard. In 1943, according to petitioners, Otis sent a memorandum to its service managers to ensure that building owners were aware of the entrapment hazard. In 1955, when ASME A17.1 first included code requirements for residential elevators, the gap between doors was limited to a maximum of 4 inches. However, in late 1981, the ASME A17.1 space requirement between the residential elevator car and hoistway doors changed from 4 inches to 5 inches.

The petitioners claim that the introduction of accordion-style elevator car doors for residential elevators in the early 1990s increased the entrapment hazard because the flexibility of a folding door and the deeper space between the peaks and valleys of the folding doors creates a gap between the car door and hoistway door that is greater than 5 inches.

The petitioners claim that at least 55 child deaths related to residential elevators have occurred since 1967 (based on dates of their incident data cited elsewhere in the petition, staff believes the petitioners meant 1947). Petitioners cite an August 2013 CPSC statement that an estimated 1,600 injuries associated with residential elevators were seen in emergency departments from 2011 through 2012. The petitioners only provide details on 16 incidents that occurred between 1958 and 2013, in which a child was purported to have been injured or killed while entrapped in the subject space in a residential elevator. However, a review by CPSC staff (Tab B) indicates that at least 13 of the 16 incidents did not involve residential elevators or were not related to the entrapment hazard identified by the petitioners; and the cause could not be determined in some incidents.

The petitioners state the ASME standard does not address the hazard; therefore, the petitioners request that the CPSC promulgate a mandatory standard that constrains the space between residential elevator hoistway doors and car doors to 4 inches when measured from the inside of the hoistway door to the farthest point on the car door. In addition, the petitioners expressed the belief that compliance with an amended ASME A17.1 would be low because jurisdictions are not required to adopt the latest version of the A17.1 Elevator Safety Code. Therefore, the petitioners believe mandatory rulemaking is required to address the child entrapment hazard in residential elevators.[1]

[1] Petitioners also requested a recall to retrofit existing residential elevators. However, the Commission's regulations provide that petitions are for the issuance, amendment, or revocation of rules.16 C.F.R. § 1051.1(a). Substantial product hazards requiring remedial action (such as repair or recall) regarding particular elevators currently in place may be appropriate under section 15 of the CPSA and reviewed by the Office of Compliance. Accordingly, only the request for rulemaking on residential elevators was docketed as a petition. 80 FR 3226 (January 22, 2015).

b. Staff's Review of the Petition

The Commission's petition regulations state factors that the Commission considers when examining a petition. These are: (1) whether the product involved presents an unreasonable risk of injury; (2) whether a rule is reasonably necessary to eliminate or reduce the risk of injury; and (3) whether failure of the Commission to initiate the rulemaking proceeding requested would unreasonably expose the petitioner or other consumers to the risk of injury which the petitioner alleges is presented by the product. The regulations further state that in considering these factors, the Commission is to evaluate the relative priority of the risk of injury associated with the product about which the petition has been filed and the Commission's available resources. 16 C.F.R. § 1051.9. In addition to the petition regulations, staff considers the CPSA's requirement that the Commission may not deny a petition on the basis of a voluntary standard, unless the Commission determines: (1) that the voluntary standard is likely to result in elimination or adequate reduction of the risk of injury and (2) substantial compliance with the voluntary standard is likely. 15 U.S.C. § 2058(i).

CPSC staff received only eight reports of incidents with victims ranging in age from 3 to 16 years that might involve entrapments between car and hoistway doors occurring between January 1, 1981, and November 10, 2016. Although CPSC staff reviewed all eight incidents to identify hazard patterns associated with residential elevator doors, in the five (5) fatal reported incidents, there was insufficient detail to determine whether an entrapment between fully closed car and hoistway doors was the cause of the fatal injuries. Nevertheless, in three nonfatal reported incidents, staff believes that entrapments occurred in the space between fully closed hoistway and accordion-style car doors. Accordingly, staff examined the potential hazard for entrapment, and assessed the current voluntary standard to determine whether such a hazard would be addressed. Staff also reviewed whether: (i) compliance with an existing voluntary standard would eliminate or adequately reduce the risk of injury addressed, and (ii) it is likely that there will be substantial compliance with such voluntary standard.

c. Product Description

ASME A17.1 defines "residential elevators" as elevators that are installed in or at private residences or in buildings providing access to a private residence, provided the elevators are not accessible to the general public. Figure 1 shows a typical residential elevator installation.

The hoistway (or shaft) in which the elevator moves is usually solidly enclosed throughout its height, except for hoistway doors at each landing access. Hoistway doors can be swinging or horizontally sliding doors or gates. Interlocks are installed to prevent the elevator car from moving unless all doors are closed and locked. Hoistway and car doors may be power-operated or manual. A typical residential elevator with a swinging exterior hoistway door and an accordion-style interior car door is shown in Figures 2. The hazard scenario can occur when a child becomes entrapped between the fully closed interior car door and the closed exterior hoistway door, as shown in Figure 3. If a child is entrapped and the elevator is called to a different landing, the child can become wedged between the moving elevator car and the stationary hoistway door and frame.

Figure 1. Typical Residential Elevator

Figure 2. Typical Residential Elevator with Swinging Hoistway Door and Accordion Car Door

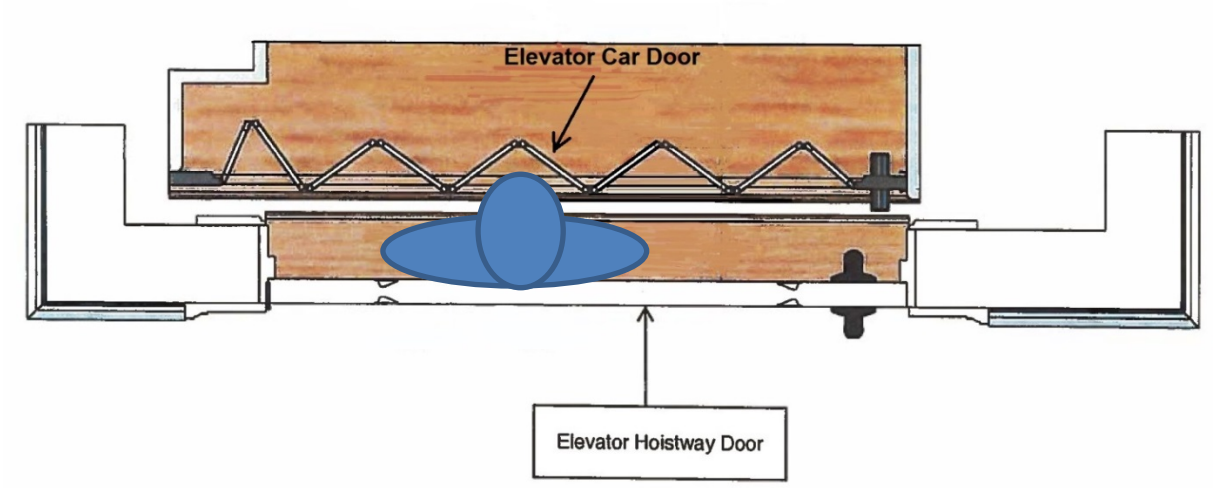

Figure 3. Depiction of Child Entrapped Between Closed Car and Hoistway Doors

Hoistway doors are generally not manufactured or supplied by the elevator manufacturer. Elevator dealers or installers work with home remodeling contractors (if the elevator is being retrofitted into an existing home) and home builders (if the elevator is being installed in new construction) to design and build the hoistway or shaft in which the elevator will be installed. The contractor involved in building or modifying the house to accommodate the elevator hoistway or shaft would be responsible for building or installing the hoistway door and sill. Typically the residential elevator hoistway door matches the other internal doors in the house.

The National Association of Elevator Contractors (NAEC), Accessibility Equipment Manufacturer's Association (AEMA), and National Association of Elevator Safety Authorities (NAESA) provide education, training, and certification programs for residential elevator installation and inspection.[2] NAEC represents independent elevator contractors and suppliers of products and services. AEMA is an association of persons and entities interested in the growth and development of private residence elevator and accessibility equipment. NAESA members are comprised of elevator inspectors, mechanics, consultants, contractors, architects, engineers, elevator manufacturers and others interested in elevator safety, code enforcement, and technology. NAESA membership includes 328 contractors, 58 associate contractors, and 293 suppliers. Quality of Elevator Inspectors (QEI) certification is obtained through NAESA, and ASME A17.1 is listed as a required codebook for the exam.[3]

NAEC, AEMA, and NAESA believe that education through seminars and direct communication with members is the key to enforcement of safety codes and standards. These groups contribute to the development, standardization, and proliferation of safety codes and standards, such as

[2] See http://naec.org/, http://www.aema.com/, and https://www.naesai.org/qei-certification for more information on elevator certification programs, *e.g.*, certification for elevator technicians, residential elevator lift technicians, and Qualified Elevator Inspectors.
[3] QEI Certification requirements retrieved from https://www.naesai.org/qei-certification.

ASME A17.1, which affect the design, installation, and use of elevator and accessibility equipment, including residential elevators.

d. Incident Data[4] (TAB B)

CPSC's Directorate for Epidemiology staff reviewed the deaths and injuries associated with residential elevator entrapments that might have been due to gaps between car and hoistway doors that occurred from January 1981 to November 2016, based on reports received by CPSC staff. The staff reviewed incidents after 1981, because the ASME A17.1 space requirement between the residential elevator car door and hoistway door was changed from 4 inches to 5 inches in 1981; staff reviewed only the incidents that may have occurred as a result of the additional space gap. The memorandum also includes the estimated number of emergency department-treated injuries from January 1981 to December 2015. The data did not include complete details of every incident.

CPSC staff received reports of eight (8) incidents with victims ranging in age from 3 to 16 years that might have involved entrapments between car and hoistway doors occurring between January 1, 1981 and November 10, 2016. There were five deaths among these eight incidents. Death certificates were the source of incident reports for all five fatalities. Table 1 shows the number of deaths by year and Table 2 shows the number of deaths by age. The remaining three nonfatal residential elevator entrapment-related incidents resulted in two injuries.

CPSC staff considered all eight incidents based on reports in IPII, INDP, and DTHS to identify hazard patterns associated with residential elevator doors. In three (3) nonfatal reported incidents, entrapments occurred in the space between fully closed hoistway and accordion-style car doors. In the five (5) fatal reported incidents, there is insufficient detail to determine whether an entrapment between fully closed car and hoistway doors was the cause of the fatal injuries.

Table 1: Residential Elevator Entrapment-Related Deaths by Year

Year	Fatalities
1981	1
1984	1
1986	1
1989	1
1995	1
Total	5

Source: CPSC epidemiological databases in the Consumer Product Safety Risk Management System (CPSRMS).

[4] The CPSC databases searched were those of the Consumer Product Safety Risk Management System (CPSRMS). These reported deaths and incidents are not a complete count of all that occurred during this period. However, they do provide a minimum number of deaths and incidents occurring during this period and illustrate the circumstances involved in the incidents related to residential elevator entrapments.

Table 2: Residential Elevator Entrapment-Related Deaths by Age

Age	Fatalities
3	1
5	2
9	1
16	1
Total	5

Source: CPSC epidemiological databases in the Consumer Product Safety Risk Management System (CPSRMS).

Based on NEISS data, there were an estimated 131 cases involving residential elevator door entrapments of some type from January 1, 1981 to December 31, 2015. However, there was not enough information provided in the case narrative to determine whether these incidents were due to gaps between fully closed elevator car and hoistway doors that led to a child being entrapped, as described in the petitions. Although the narratives associated with these cases are very brief, most appear to involve hand and finger entrapments in elevator doors, rather than the specific hazard scenario identified by the petitioners. Therefore, there are an insufficient number of cases to generate a national estimate of emergency department-treated injuries associated with residential elevator door entrapments.[5]

e. Market for Residential Elevators (TAB C)

The CPSC Directorate for Economic Analysis provided information on the market for residential elevators. Staff identified at least seven firms that supply residential elevators in the United States. Of these suppliers, three are domestic manufacturers, and four are foreign manufacturers who export directly to the United States via U.S. dealers or distributors. All three domestic manufacturers have fewer than 500 employees and would be classified as a small business under the criteria established by the U.S. Small Business Administration (SBA).

In 2013, there were approximately 125,000 swing-door elevators in use and approximately 5,000 are sold annually.[6] In 2013, the typical cost of a residential elevator ranged from $15,000 to $30,000.[7] Residential elevators are sold through dealers or retailer networks that are often affiliated with a manufacturer. The dealer usually arranges for the installation of the elevator.

[5] According to the NEISS publication criteria, an estimate must be 1,200 or greater, the sample size must be 20 or greater, and the coefficient of variation must be 33 percent or smaller.
[6] Hubler, Shawn. "Elevator Safety Flaws Persist Despite History of Tragic Accidents." FairWarning.org. December 18, 2013. Available at: http://www.fairwarning.org/2013/12/elevator/.
[7] "Home Elevator Prices for 2013." http://www.elevatordesigninfo.com/home-elevator-prices-for-2013.

f. Preliminary Estimates of Societal Costs

The Directorate for Epidemiology identified fatalities that might have involved entrapment between an elevator car door and the hoistway door. However, there were insufficient details to determine whether entrapment between a fully closed car door and hoistway door was, in fact, the cause of deaths. Similarly, the Directorate for Epidemiology was unable to estimate the number of nonfatal injuries that would be addressed by the petition because there was not enough information available in the NEISS records to determine if these cases were due to gaps between elevator car doors and elevator hoistway doors, as described in the petition. Because there is insufficient information to determine the number of deaths or estimate the number of injuries associated with this hazard, staff cannot estimate the societal costs associated with this hazard.

g. Human Factors Discussion of Incident Data and Behavior (TAB D)

The Directorate for Human Factors (HF) staff provided a discussion regarding the residential elevator entrapment hazard described by the petitioners, and the effectiveness of a 4-inch gap between the elevator car and hoistway doors. (TAB D) According to staff, head size is the determining factor as to whether a young child can fit entirely within the space between the closed car and hoistway doors. If the child's head is larger than the available space, the exterior door will be unable to close completely, thereby preventing the entrapment hazard scenario.

Even the smallest head breadths of children aged 2.0 to 3.5 years, which encompasses the youngest known victims of the hazard scenario, are likely to be larger than 4 inches. For example, the minimum and 5^{th} percentile head breadths of children this age are 4.7 inches (11.9 cm) and 4.9 inches (12.5 cm), respectively. These anthropometric data suggest that allowing a space between the car and hoistway doors of no more than 4 inches would effectively address the entrapment hazard identified in the petition. Limiting this space to 4 inches would prevent all but the smallest of the youngest infants (*e.g.*, small newborns) from fitting completely within the closed space, and this group is highly unlikely to be involved in the hazard scenario.

h. Review of Voluntary Standard for Residential Elevators (TAB E)

Currently, there is no CPSC regulation for residential elevators. There is one voluntary standard pertaining to the design of residential elevators, ASME A17.1 *Safety Code for Elevators and Escalators*. This standard specifies requirements for elevators, escalators, dumbwaiters, moving walks, material lifts, and dumbwaiters with automatic transfer devices. ASME A17.1-2013 was the existing voluntary standard at the time the petition was submitted on November 1, 2013. As discussed below, ASME has since revised the standard.

ASME A17.1 Section 5.3 applies to private residence elevators. The 2013 version of ASME A17.1 allowed a 5-inch gap between the hoistway face of the elevator hoistway door or gate (exterior door) and the elevator car door or gate (interior door).

ASME A17.1 -2013, section 5.3.1.7.2, Clearance Between Hoistway Doors or Gates and landing Sills and Car Doors and Gates. The clearance between the hoistway doors or gates and the hoistway edge of the landing sill shall not exceed 75 mm (3 in.). The distance between the hoistway face of the landing door or gate and the car door (or) gate shall not exceed 125 mm (5 in.).

Staff's review of ASME A17.1-2013 identified three issues that could contribute to an entrapment hazard between fully closed elevator hoistway and car doors:

1. A 5-inch dimension between the hoistway and car door exceeds the head breadths of small at-risk children (see Tab D).
2. There is no requirement for how the dimension in measured. The prevalent use of accordion-style car doors allows for gaps greater than 5 inches when measured between the "Vs" of the interior door and the exterior door. This larger space increases the risk that children can fit and become trapped. The petitioners claim that such spaces could trap children up to 12 years of age.
3. There is no requirement for the rigidity of the car and hoistway doors. Thus, if either door can deform with minimal force, it can create a gap greater than 5 inches and permit older children to become trapped.

ASME A17 Residence Elevator committee membership includes 14 voting members and 11 non-voting members. The voting membership includes representation from a mix of manufacturers, retailers, distributors, and installers.

In June 2013, the ASME A17 standards committee balloted several proposed changes to A17.1-2013, which included a draft ballot for the residential elevators section. In January 2015, the proposed changes to the residential elevator requirements passed, and ASME A17.1-2016 was published on November 30, 2016. It becomes effective on May 30, 2017.

As described in Section II.b, staff considered two factors when examining this petition:

(i) Whether compliance with an existing voluntary standard is likely to eliminate or adequately reduce the risk of injury addressed.

ASME A17.1-2016 added section 5.3.1.8.3, which specifies the clearance between residential elevator hoistway doors and car doors to prevent an entrapment hazard. The new section specifies a clearance not to exceed 4 inches for five different car and hoistway door combinations.

ASME A17.1-2016 added requirements to address entrapment gap:

a. *Power operated horizontally sliding hoistway and car doors.* For this combination, the measurement of the leading edge of the doors shall not exceed 100 mm (4 in.).

b. *Swinging hoistway doors and folding car doors.* For this combination, when both doors are in the fully closed position, the space between the doors shall reject a 100 mm (4 in.) diameter ball at all points.
c. *Swinging hoistway doors and car gates.* For this combination, the space between the doors shall reject a 100 mm (4 in.) diameter ball at all points.
d. *Swinging hoistway doors and power operated horizontally sliding car doors*. For this combination, where the car door(s) cannot be closed until after the hoistway door is closed, and the car door(s) automatically open when the car is at a landing and the hoistway door is opened, the measurement between the hoistway face of the hoistway door and the hoistway face of the car door shall not exceed 100 mm (4 in.). Where either door can be disconnected from the operator (control) and then allow the user to operate the door manually, 5.3.1.8.3(e) shall apply.
e. *Swinging or horizontally sliding hoistway doors and manually operated horizontally sliding car doors*. For this combination, when both doors are in the fully closed position, the space between the doors shall reject a 100mm (4 in.) diameter ball at all points.

ASME A17.1-2016 also added section 5.3.1.8.2 (d), which specifies the strength and deflection of doors, gates, and their guides, guide shoes, track, hangers. This section addresses the hazard of an entrapment space created between the hoistway door and elevator car door due to one or both doors deflecting and creating a hazardous gap.

ASME A17.1-2016 added requirements to address deflection of doors:

1) Horizontal sliding car doors and gates when fully closed shall be designed and installed to withstand a force of 335 N (75 lbf) applied at any location on the door without exceeding a deflection of 19 mm (0.75 in.) and without permanent deformation.
2) Folding car doors when fully closed shall be designed and installed to withstand a force of 355 N (75 lbf) applied using a 100 mm (4 in.) diameter sphere at any location within the folds on the door without exceeding a deflection of 19 mm (0.75 in.) and without permanent deformation.

Staff believes that the current edition of ASME A17.1-2016 addresses the petitioner's concern for new residential elevator installations by: (1) specifying a clearance of no more than 4 inches between the elevator car and hoistway doors, (2) specifying a test method to determine the clearance is not exceeded, including at all points along a closed accordion style door, and (3) specifying a rigidity of the elevator doors. According to CPSC human factors staff (TAB D), limiting the dimension between the car and hoistway door to no more than 4 inches will address the entrapment hazard because the only children who would likely fit completely within this space would be the smallest of the youngest infants (*e.g.,* small newborns). These children are not known to be, and are highly unlikely to be, involved in the hazard scenario identified in the petition. No entrapment incidents are associated with infants under 3 years of age.

The 4-inch requirement addresses the hazardous 5-inch dimension between the hoistway and car door and exceeds the head breadths of small at-risk children by removing the potential for accordion style car doors to create gaps greater than 5 inches when measured between the "Vs"

of the car door and the hoistway door. The requirement specifying the rigidity of the car and hoistway doors ensures that the doors cannot become deformed with minimal force and create a hazardous gap.

ASME also has a standard for existing elevators, ASME A17.3-2015, *Safety Code for Existing Elevators and Escalators*, which is currently in the ballot process to require the same residential elevator door clearances and rigidity test method as required under ASME A17.1-2016. These changes would address potential entrapment hazards on existing elevators. CPSC staff will continue to monitor ASME A17.3-2015 standard activities.

(ii) Whether substantial compliance with the voluntary standard is likely.

Staff believes the revisions in ASME A17.1-2016 would address the potential the hazard, because the only children who would likely fit completely within the 4-inch space would be the smallest of the youngest infants (*e.g.*, small newborns). These children are not known to be, and are highly unlikely to be, involved in the hazard scenario identified in the petition.

Staff reviewed the elevator building codes of all 50 states. Almost all the states reference ASME A17.1 in the state elevator building code requirements. However, many states need to update their references to the latest version of the standard on their website. The ASME A17 Committee has established the A17 Regulatory Authority Council, which facilitates the dissemination of the latest code changes to jurisdictional authorities. Staff will contact ASME to alert the state regulatory bodies that the newest version (2016) is available and should be reflected if the latest version is not indicated in the existing state code. Staff believes that by working with the ASME A17.1 Committee to alert state regulatory bodies to update references to the current standard, substantial compliance to the voluntary standard will be more likely.

Staff believes that industry will be alerted to the new requirements in the voluntary standard because the committee that developed the revised standard is comprised of elevator manufacturers and elevator installers. In addition, associations, such as NAEC, AEMA, and NAESA, promote the latest safety information to elevator manufacturers and installers through the HomeSafe Campaign (HomeSafe), which provides homeowners, manufacturers, and installers with information on how to install, operate, and maintain their home elevators safely. Membership in these organizations is comprised of elevator inspectors, mechanics, consultants, contractors, architects, engineers, elevator manufacturers and others interested in elevator safety, code enforcement, and technology. NAESA members include 328 contractors, 58 associate contractors, and 293 suppliers. Quality of Elevator Inspectors (QEI) certification is obtained through NAESA and ASME A17.1 is listed as a required codebook for the exam, and the 2016 revision will become mandatory code for certification in fall 2017.

i. Comments to Petition Docket

On January 22, 2015, a notice of petition requesting comments was published in the *Federal Register* (80 FR 3226). The comment period ended on March 23, 2015. The Commission received several comments supporting the petition request. Kids in Danger (KID) supported the

need for a mandatory standard to address the entrapment hazard posed by certain residential elevators noting that the hazard is not readily apparent to elevator owners. KID also pointed out that safe alternatives and ''fixes'' exist and can be made available to elevator owners. Two submissions were received after the comment period, Handi-Lift and Dennis Brickman. Handi-Lift disagreed with the petitioners' incident data and how it was derived; however, Handi-Lift agreed with the petitioners' claim that an excessive gap between the elevator car and hoistway doors presents a serious safety issue that can allow children to become entrapped between fully closed car and hoistway doors. Handi-Lift stated that the industry has taken steps to correct the hazard by adopting the ASME requirements on door clearances, and also indicated that residential home elevator safety may be advanced through education. Dennis Brickman reported an elevator incident that occurred in Little Rock, AR in February 2017, when a 2-year-old was found in an elevator shaft. In addition, Brickman submitted three technical papers that address accident reconstruction incidents associated with residential elevator child entrapments.

Response to Comments: Staff agrees that a potential entrapment hazard exists for children from the excess gap allowed between the car door and hoistway doors that were permitted in the earlier version of the ASME A17.1 voluntary standard. However, staff believes that 2016 revisions to the standard address the hazard by reducing the maximum gap between the internal and external elevator doors from 5 inches to 4 inches, and by specifying an effective test method for measuring the gap and door rigidity requirements. Staff believes that a maximum gap of 4 inches between the interior and exterior doors of residential elevators, combined with the deflection limits, will address the entrapment hazard because the only children who would likely fit completely within this space would be the smallest of the youngest infants (*e.g.*, small newborns). These children are highly unlikely to be involved in the hazard scenario identified in the petition. Staff is also investigating the incident reported in Little Rock, although it is unclear whether the accident occurred due to the excess gap between the car door and hoistway door.

j. CPSC Compliance Actions

CPSC has not recalled any elevators related to the entrapment hazard identified by the petitioners. CPSC staff could not identify any specific elevator models or manufacturers whose installations revealed design defects or installation defects that caused a substantial product hazard resulting from an excess space gap between the car door and hoistway. However, staff has noted that space guards and similar retrofit products are available in the marketplace for approximately $90. Moreover, most of the industry participates in the HomeSafe Campaign (HomeSafe), which provides homeowners, manufacturers, and installers with information on how to install, operate, and maintain their home elevators safely. The participants in this campaign include AEMA, NAEC, NAESA, and ThyssenKrupp Access Corp.

Staff did initiate three recall programs related to residential elevators. Although none of the recalls was related to the entrapment hazard identified in the petition, there were issues related to the improper opening or closing of residential elevator doors.

1) CPSC Recall 12-750 Residential elevator hoistway doors can unlock and open without the elevator car present. There were no injuries related to the hazard.

2) CPSC Recall 15-102 Residential hydraulic elevators can operate while the interior gate door is open, posing a crushing hazard. Three reported incidents with one catastrophic brain injury to a 10-year-old boy.
3) CPSC Recall 16-238 Residential elevators with plastic electro mechanical door locks (EMDLs) that can operate with the hoistway door open without the elevator car present. There were no injuries related to the hazard.

III. Commission Options

In response to the petition, the Commission may:

1. Grant petition CP15-01 and initiate rulemaking;

If the Commission concludes that the available information indicates the risk of injury from entrapments due to excessive space between the hoistway and car door of residential elevators can be addressed by a mandatory standard as requested by the petitioner, the Commission may grant the petition. Granting the petition does not mean that the Commission would necessarily issue a rule in the specific form requested in the petition.

By granting the petition, the Commission could begin rulemaking if the Commission determines that a rule is necessary to limit the space between the car door and hoistway door of residential elevators to no more than 4 inches when measured from the inside of the hoistway door to the farthest point on the car door.

Staff believes the revision made to ASME A17.1-2016 specifies adequate requirements to constrain the space between the car door and hoistway door of residential elevators to no more than 4 inches. Therefore, staff does not recommend that the Commission grant the petition.

2. Deny petition CP15-01

If the Commission determines that a mandatory rule to address the hazard that petitioners identify is not warranted, the Commission could deny the petition.

Staff believes that the revision to ASME A17.1 for residential elevators addresses the petitioners concerns for entrapment between car and hoistway doors by: (1) specifying a clearance of no more than 4 inches between the elevator car and hoistway doors, (2) specifying a test method to determine the clearance is not exceeded, including at all points along a closed accordion style door, and (3) specifying a rigidity of the elevator doors. In addition, staff believes that substantial compliance with the voluntary standard will be likely if staff works with the ASME 17.1 Committee to alert state regulatory bodies of the new requirements in the voluntary standard. Therefore, staff recommends the Commission deny the petition.

Denying the petition does not preclude the Commission from taking action to address the risk of entrapment in residential elevators.

3. Defer decision on petition CP15-01

If the Commission concludes that more information is required before the Commission can decide whether to grant or deny the petition, the Commission may defer a decision and direct the staff to collect additional information or take other action.

Deferring the petition does not preclude the Commission from initiating future rulemaking in response to this or another petition.

IV. Recommendations

Staff recommends that the Commission deny the petition. Staff reviewed the voluntary standard to assess whether there could be a potential for an entrapment hazard between the car door and the elevator door. Staff's review showed that the current voluntary standard for residential elevators, ASME A17.1-2016, *Safety Code for Elevators and Escalators,* addresses the potential hazard of child entrapment between the elevator car door and elevator hoistway doors. In addition, if state building codes are updated to require safety inspections that meet the ASME A17.1-2016 requirements by fall 2017, staff expects that substantial compliance to the revised standard for new residential elevators will be likely. Staff will work with the ASME A17 committee to alert state regulatory bodies on the new requirements in the voluntary standard.

TAB A: Petition from The Safety Institute, Carol Pollack-Nelson, and Cash, Kruger & Fredericks to set safety standards for the design and installation of residential elevators

UNITED STATES CONSUMER PRODUCT SAFETY COMMISSION

Petitioners:
The Safety Institute
Carol Pollack-Nelson, Ph.D., Independent Safety Consulting
Cash, Krugler & Fredericks, LLC

PETITION FOR RECALL TO REPAIR/RETROFIT AND RULEMAKING

Petitioners, The Safety Institute, Carol Pollack-Nelson, and Cash, Krugler & Fredericks, LLC (hereinafter "Petitioners"), pursuant to 16 C.F.R. § 1051 Procedure for Petitioning for Rulemaking, request that the U.S. Consumer Product Safety Commission initiate mandatory rulemaking to set safety standards for the design and installation of residential elevators to eliminate excessive space between the elevator car door/gate (interior door) and hoistway or swing door (exterior door).

In many home elevators, and similar versions found in older apartment and commercial buildings, the clearance between the two doors is large enough to allow children as old as 12 years to fit between them. When the elevator is called to another floor, the hoistway door automatically locks, and the child's body is carried along with the elevator car until it meets the obstruction of the sill, where the child's body – usually the head – is crushed. Industry has been aware of these dangers for more than 80 years, but has failed to adopt an appropriate, safe voluntary standard to address this design flaw. At least 55 child deaths have occurred since 1967; the most recent known death occurred in 2009. Since 2010, there have been three serious permanent debilitating injuries resulting from child entrapment.

A mandatory standard is required because the gap between the doors that is permitted by the voluntary standard has caused deaths and serious injuries. Efforts to work through the voluntary standards process, as described in this petition, have not adequately addressed the defect and therefore, have not reduced the risk of harm. In fact, 35 years ago, the voluntary standards committee actually changed the dimensions for residential elevators from a maximum gap of 4 inches between the two doors, to the less-safe 5-inch gap.

The petitioners also request that the U.S. Consumer Product Safety Commission order a recall (to repair) of all residential elevators that allow a gap between the hoistway and swing doors of more than 4 inches. Recalled defective doors should be retrofitted with a device that would either detect the presence of a child or small adult in the door path and prevent the elevator from operating or physically fill the gap to prevent children and small adults from becoming entrapped.

Industry Knowledge of Design Defect

The elevator industry has known about the entrapment hazard in swing door elevators for

at least eight decades. In 1931, Otis Elevator Company obtained a patent for an inexpensive 6-inch space guard to prevent child entrapment. In 1932, Otis sent a letter to its customers warning them about this hazard.[1] In 1943, the company followed up; an Otis General Service Manager sent an inter-office memo reiterating the dangers of excessive space between the hoistway doors and the threshold. The elevator company was concerned that buildings may have changed hands since the original alert went out, leaving the current owners unaware of the threat, or that the original owner ignored the warning or installed a space shield, which fills the gap and makes it impossible for a child to fit in the space, but failed to remove projecting hardware.[2]

In 1955, the first Residence Elevator Code addressed the entrapment issue. ASME Elevator Safety Code limited distance between the doors to a maximum of 4 inches. (At the time, there were no accordion doors on elevators – this was a flat-to-flat measurement.)[3] But, in 1981, for unknown reasons, the ASME changed the rule to widen the gap, allowing a maximum of 5 inches between the doors.

ASME standard A 17.1, Sec. 5.3.1.7.2 states:

> Clearance Between Hoistway Doors or Gates and Landing Sills and Car Doors or Gates. The clearance between the hoistway doors or gates and the hoistway edge of the landing sill shall not exceed 75 mm (3 in). The distance between the hoistway face of the landing door or gate and the car door or gate shall not exceed 125mm (5 in.). [4]

In 1950, Otis General Service Manager again noted "recent occurrence of accidents" caused by excessive space between the hoistway and elevator car doors, suggesting that many elevators remained unremedied.[5] A 1963 memo noted the rise in liability claims against the company and suggested a survey of all Otis elevators under a service contract with sub-standard safety conditions– including the condition of too much space between the hoistway and elevator doors.[6]

In the early 1990s, the residential elevator industry introduced accordion doors for home elevators; this only increased the entrapment hazard. The accordion door's flexibility and its peaks and valleys create excess space, above and beyond the 5-inch gap permitted by

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[1] Subject: Automatic Elevator Space conditions Between the Hoistway Doors and the Threshold; H.R. Otto; Otis Elevator Company; September 30, 1943.
[2] Subject: Automatic Elevator Space conditions Between the Hoistway Doors and the Threshold; H.R. Otto; Otis Elevator Company; September 30, 1943
[3] American Standard Safety Code for Elevators; Private Resident Elevators and Inclined Lifts; American Society of Mechanical Engineers; June 15, 1955
[4] Standard A 17.1, Sec. 5.3.1.7.2; ASME
[5] Terry Garmey Speaks About Tucker Smith and the Campaign to Repair 4,000 Guards on OTIS Elevators; Smith Elliott Smith & Garmey; http://www.fairwarning.org/wp-content/uploads/2013/12/TuckerSmithArticle.pdf
[6] Terry Garmey Speaks About Tucker Smith and the Campaign to Repair 4,000 Guards on OTIS Elevators; Smith Elliott Smith & Garmey: http://www.fairwarning.org/wp-content/uploads/2013/12/TuckerSmithArticle.pdf

the ASME Standard. A child or small adult can fit into those valleys, and when the hoistway (exterior) door is closed and the elevator moves, they can be seriously injured or killed. Some elevator designers, installers and others purportedly following the ASME A 17.1 5-inch rule do not take into account the extra space created by the valleys, which, in effect, can increase the gap by an additional three inches or more.

In 2003, the Otis Elevator Company, as part of a settlement with the family of an eight-year-old boy who died after becoming entrapped between elevator doors, launched a national safety campaign, equipping 4,000 elevators with space guards. Otis also sent letters to other manufacturers urging them to check the size of the gap between elevator doors and offered free space guards for Otis-manufactured elevators:[7]

> Over the years, a number of tragic accidents have occurred on elevators with swing-type hoistway doors, including the deaths of numerous children. These accidents have demonstrated the safety risk posed by elevators with swing doors. If the hoistway door and car gate are both closed, the space between them would be wide enough to fit a child or small adult. Should the elevator be called up while the person is in that space, serious injury or death is likely to result. These tragedies can be avoided.[8]

In addition, Otis' Director of Worldwide Standards, Lou Bialy, highlighted the danger posed by this defect in a trade publication, Elevator World, entitled *Space Between Swing Doors Collapsible Gates Still A Hazard*.[9] As recently as March 2014, elevator experts James Filippone and John Koshak reiterated the dangers of child entrapment in another Elevator World article entitled *Solutions Needed to Ensure Children's Safety*.

Safer and Feasible Alternative Designs

Safer design options reduce the gap between the hoistway and car doors. Such designs recognize the ergonomic factors that contribute to the hazard. For example, as the CPSC's own anthropometry data show, children's heads are larger than their bodies, and the most vulnerable children, ages 2-3.5 years, have head breadths of less than five inches.[10]

The CPSC and others have identified 4 inches as a key element of safe design in other contexts, such as the allowable space between staircase spindles, specifically to prevent head entrapment.[11] The CPSC's Public Playground Safety Handbook recommends a more conservative maximum allowable gap of 3.5 inches, specifically to prevent a child's

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[7] Letter to National Wheelovator; Raymond Moncini; Otis Elevator Company; December 8, 2003
[8] Letter to National Wheelovator; Raymond Moncini; Otis Elevator Company; December 8, 2003
[9] Space Between Swing Doors Collapsible Gates Still A Hazard; Lou Bialy; Elevator World; May 2003
[10] Change in the Physical Dimensions of Children in the United States; U.S. Consumer Product Safety Commission; April 27, 1998
[11] Ergonomics and Design Review; Rani Leuder; *Helvey v. ThyssenKrupp Access Corporation*; October 22, 2012

head from entering the space and becoming entrapped.[12]

In addition, history shows that the design alternatives are feasible. From 1955, when ASME's first residential elevator code was published, until 1980, when the dimension was changed, the voluntary industry standard called for a maximum gap of 4 inches between the two doors.

Individual states have more stringent standards than those set by ASME. Massachusetts' elevator code, for example, restricts any gap between the hoistway doors and the car doors or gates to 3 inches.[13] In the state of Georgia, an effort to follow suit is underway. The amendment to the International Residential Code proposed by the State Fire Marshal's office, which oversees elevator codes, reads:

> Passenger elevators, limited-use/limited-application elevators or private residence elevators shall have hoistway landing openings that meet the Georgia amended requirements of ASME A17.1 Sections 5.3.1.1 and 5.3.1.7.2. The clearance between the hoistway doors or gates and the hoistway edge of the landing sill shall not exceed 3/4 inch (19 mm). The distance between the hoistway face of the landing door or gate and the car door or gate shall not exceed 3 inches (75 mm).[14]

This change is scheduled to be finalized by the Georgia Department of Public Affairs in November and go into effect in January 2015.

A reduction of the clearance is feasible because it does not change the manufacture of the elevator itself; rather it guides the installation of the hoistway door. Currently, in residential settings, the exterior door is typically set flush to the wall, like any other door in a home. This setting typically creates the excessive gap. Installers can exacerbate the gap by misinterpreting the 5" Rule in the voluntary standard as measuring the distance between the *closest* points between the doors, rather than the furthest point. In fact, manufacturers' designs often instruct installers to measure between the hoistway door and the peak of an accordion car door, rather than to the valley. Those who do not take into account the extra space beyond the peak of the accordion door can create up to 8 inches of refuge space, which permits entry by a child.

Voluntary Standards Have Not Prevented Risk of Harm

In 83 years, the industry not only has failed to address the entrapment hazard, it actually increased the potential for injury and death by re-writing the voluntary standard to allow a wider gap between the hoistway and exterior door.

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[12] Public Playground Safety Handbook; U.S. Consumer Product Safety Commission; undated

[13] 5.3.1.7.2 Clearance Between Hoistway Doors or Gates and Landing Sills and Car 'Doors or, Gates; 5.3.1. 7 Protection of Hoistway Openings.; 524 CMR Board of Elevator Regulations; PDF Pg. 214; September 28, 2012

[14] Georgia State Amendments to the Residential Elevator Codes for One and Two-Family Dwellings; August 13, 2014

The voluntary ASME standard has failed to safeguard children from injuries and deaths. According to CPSC's own figures, there were an estimated 1600 injuries associated with residential elevators in just a two-year period.

> The most recent figures from CPSC's NEISS system show that an estimated 1,600 injuries associated with residential elevators and lifts were seen in emergency departments from 2011 through 2012. CPSC only has jurisdiction over elevators customarily used by consumers in a residential setting. Some of those injuries included children becoming entrapped in the gap of residential elevators, tragically leading to fatalities and serious injuries. The agency has an active and ongoing compliance investigation regarding the safety of residential elevators and the entrapment hazard they can present. While CPSC investigates the role and responsibilities of manufacturers and installers when it comes to the safety of residential elevators, owners of residential elevators should take steps to ensure children do not have unsupervised access to in-home elevators. [15]

In addition, the entrapment hazard has led to a number of child deaths. In the early1990s, the Otis Elevator company revealed to the plaintiffs in a New Jersey case the deaths or severe injuries to 34 children from 1983-1993 in the southern New York and New Jersey area alone[16] and an additional 16 deaths from 1947 to 1963.[17] More recently, the petitioners are aware of five more deaths and two catastrophic injuries in which children were entrapped and crushed in residential elevators.[18]

The ASME Voluntary Standards Process Has Been a Failure

The ASME standards-setting process has not produced a substantive change to the voluntary residential elevator standard in nine years of committee meetings, despite members repeatedly bringing up the excessive gap issue.

In 2005, the A-17 committee began discussing revisions to the "Clearance" section of the standard. Several members of the A-17 Committee lobbied to change the Clearance dimensions of the standard back to the original dimensions. Minutes of the committee meetings between September 2006 and June 2007 show that some committee members expressed concern about the hazardous gap permitted by the standard. However, the group rejected any proposals for revising the standard to require tighter clearances and more precisely described measuring points to ensure that home elevators would comply.[19]

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[15] Email to The Safety Record Blog; Scott Wolfson; US Consumer Product Safety Commission ; August 27, 2013
[16] The Elevator Design Hazard That's Been Killing Children for Decades; The Safety Record Blog; July 11, 2013
[17] Elevator Safety Flaws Persist, Despite History of Tragic Accidents; Shawn Hubler; Fair Warning; December 8, 2013
[18] Appendix A; Elevator Entrapment Deaths and Injuries
[19] A17 Residence Elevator Committee; Minutes; September 19, 2006- June 18, 2007

For example, Calvin Rogler, chief of the state of Michigan's Elevator Safety Division, suggested that the language be modified to only allow for a 4-inch clearance, because when accordion doors are used, the clearance from the face of the hoistway door to the furthest part of the accordion door resulted in a clearance of 5.5-inches. At one such meeting, he said "The clearances between the car and the hoistway door must be reduced to provide an acceptable level of safety for the families using this device. Accidents dealing with this area have been deadly."[20]

Another committee member, Richard Gregory, an elevator consultant, described an incident that occurred in Michigan in which a 10-year-old boy who had slipped between the hoistway door and the accordion door was fatally crushed when the lift was called to a floor below. It would be easy to reduce clearances in elevators with wide gaps with products readily available on the market, he said in an email to the committee chairman.[21]

"It's easy, it saves lives. So it should be done," Gregory wrote.[22]

Despite repeated attempts to persuade the majority of members that the excessive gap was a serious safety problem that resulted in a child's death, the committee decided that the status quo should remain: "The committee feels assured that the measurement criteria presented will provide for adequate safety. In addition, the 5-inch dimension has been in the standard for many years."[23]

Not only has the subcommittee failed to revise the standard in order to adequately address this hazard, they recently considered making the Clearances section of the standard even more lenient. At the first quarterly meeting of 2013, the committee was poised to codify the latest revisions, which included measuring instructions that would have allowed designers to consider the shortest point when measuring the clearance, instead of the farthest point. Fortunately, a member of the larger standards committee made an impassioned and successful plea to reject the change.

More recently, the committee shelved a proposal to reduce the gap between the doors on existing elevators to a 4-inch maximum, while it awaits the results of an internal hazard analysis. Although the A17 committee had been looking at this issue since 2005, they just voted to perform a hazard analysis last year. The committee also weighed a proposal to clarify the rule and make explicit that the 5-inch maximum dimension/constraint must be measured between the farthest points between the doors – not the closest. Even if the Committee immediately approved both, any rule change is effectively delayed for another three years, when the next edition of the Elevator Safety Code is published.

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[20] A17 Residence Elevator Committee; Minutes; September 19, 2006- June 18, 2007; Carl Rogler; PDF Pg. 10; Responses to Letter Ballott #05-1123 Comments; November 28, 2005
[21] Accordion Door Accident; email; Richard Gregory to Al Vershell; June 27, 2006
[22] Accordion Door Accident; email; Richard Gregory to Al Vershell; June 27, 2006
[23] A17 Residence Elevator Committee; Minutes; September 19, 2006- June 18, 2007; Carl Rogler; PDF Pg. 10; Responses to Letter Ballott #05-1123 Comments; November 28, 2005

We have no reason to believe that will happen. Nine years have elapsed since the ASME committee first considered modifying requirements for clearances. To date, the standard still has not been revised to effectively address the hazard. Clearly, industry has demonstrated its unwillingness to correct the problem on its own and there is insufficient industry buy-in supporting the change. For example, when one member suggested amending the rule to reflect that the measurements should be taken from the farthest points, it was rejected: "The Committee feels assured that the measurement criteria presented will provide for adequate safety." [24] In another instance, a small group within the committee voted against the proposed rule, with one member arguing: "Those clearances between the car and hoistway doors must be reduced to provide an acceptable level of safety for the families using this device. Accidents dealing with this area have been deadly for those involved." [25]Even when confronted with the history of child deaths, the response was: "The committee feels assured that the measurement criteria presented will provide for adequate safety. In addition, the 5"inch dimension has been in the standard for many years."[26]

More importantly, even if ASME A17 amends the rule, its adoption is not automatic. Any jurisdiction (whether city, county or state) may adopt any version of the A17 Elevator Safety Code. Many jurisdictions are decades behind. For example, some states today use the 2004 or older versions, even though there have been many subsequent versions. Other jurisdictions, such as South Carolina, do not have any code for residential elevators and do not require permitting or inspections for single family residential elevators. Children represent a vulnerable population who need the protection of a strong mandatory standard when the voluntary standards process has repeatedly failed to offer reasonable and feasible protections against potentially grievous injury.

The ASME's standard-setting process, unfathomable delays and rationale for rejecting proposed changes is at odds with the purpose of developing a safety standard. Industry's inaction is even more egregious given that methods for addressing the hazard are technologically and economically feasible and have been for many years. Further, to conclude that a standard should not be changed simply because it has existed for many years is not the result of a credible standards-writing process.

Ironically, the elevator industry has launched the homeSAFE (Safety Awareness for Elevators) Campaign, to increase home elevator safety awareness. The campaign is sponsored by Association of Members of the Accessibility Equipment Industry (AEMA), National Association of Elevator Contractors (NAEC), National Association of Elevator Safety Authorities International (NAESA) and ThyssenKrupp Access. The HomeSAFE Campaign recommends that homeowners make sure the gap between the accordion and swing doors be no more than 4 inches, even as the ASME committee refused to codify this advice into its own standards:

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[24] TN05-803 Residence Elevator Committee; Attachment 8C; Pg. 5
[25] TN05-803 Residence Elevator Committee; Attachment 8C; Pg. 6
[26] TN05-803 Residence Elevator Committee; Attachment 8C; Pg. 6

Measure the gap between the elevator door and the hoistway door to verify it is not wide enough for a child to become entrapped. ASME Codes require the space be no more than 5 inches; but for additional safety precautions, homeSAFE recommends the space between the hoistway door and cab gate is no more than 4 inches. Features such as space guards or special hoistway doors can help reduce the space between the elevator door and the hoistway door. Other safety devices such as light curtains also may help detect someone in the space between doors.[27]

Petition Request

The Petitioners hereby formally submit this Petition for Rulemaking under the authority and process set forth in 16 CFR § 1051 Procedure for Petitioning for Rulemaking and request the Commission to promulgate a mandatory standard that constrains the space between residential elevator hoistway doors and car doors/gates to 4 inches when measured from the inside of the hoistway door to the farthest point on the car door/gate (*i.e.,* the valley for an accordion door).

Under Sec. 9 [15 U.S.C.§ 2058] Procedure for Consumer Product Safety Rules, the Commission must meet certain criteria to commence a rulemaking: identify the product and the risk of injury associated with that product, ensure a rule is in the public interest, and consider the adequacy of any already existing voluntary standard in eliminating or adequately reducing an unreasonable risk.

The petitioners believe that the record clearly establishes the hazard – the entrapment risk posed by excessive space between the inner and outer elevator doors; the significant risk of injury and fatality; and the failure of the voluntary standard to mitigate or eliminate the hazard despite the feasibility of a technical fix.

To ensure the safety of existing elevators, the Petitioners also request that the Commission commence a recall to repair, requiring all manufacturers to retrofit existing elevators to prevent children and small adults from becoming entrapped. Several technologies exist to eliminate this hazard. For example, light curtains use light beams and sensors to detect a presence between the doors and interrupt the operation of the elevator if something or someone is in this space. This would prevent the scenario of the elevator car being called to another floor while a child is entrapped between the car door/gate and the hoistway door. Door baffles (or space guards) are another potential solution. These after-market space blockers fill the excess clearance space, removing the opportunity for children or small adults to fit themselves in the space between the car and hoistway doors.

The Petitioners appreciate the Commission's consideration of this request. We are available to discuss this petition at your convenience.

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[27] http://homesafecampaign.com/safe-home-elevator-installation/

Respectfully submitted,

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Interest of Petitioners

This petition is brought by three organizations on behalf of all children and their families affected by residential elevators:

The Safety Institute is a 501 (c) 3 non-profit organization whose focus is on injury prevention and product safety. The Safety Institute examines areas of injury prevention and product safety across a broad spectrum. The Institute bases its plans and priorities on issues that require greater study and emphasis, as well as those which may be underserved by other organizations and advocates. The Institute gives special attention to those areas of emerging importance to injury and product safety, including the effects of new and changing technologies.

Independent Safety Consulting (ISC), through its principal, Carol Pollack-Nelson, provides human factors consulting specializing in consumer product safety, by evaluating product designs, warnings and instructions in order to identify hazards and reduce risks to consumers. Ms. Pollack-Nelson was a Human Factors Psychologist at the CPSC from 1988 through 1993.

Cash, Krugler & Fredericks, LLC is a law firm representing victims and their families in cases involving catastrophic injury and death. The firm pursues this petition on behalf of the families with whom they have worked whose children have suffered brain injuries, paralysis and other disabilities due to residential elevator hazards.

Appendix A

Elevator Entrapment Deaths and Injuries

According to CPSC statistics, there were an estimated 1,600 injuries associated with residential elevators in a two-year period. The following incidents are a small sample of the injuries and deaths:

1958: Three-year-old girl died, caught between the inner grill and outer door [redacted] California

- The three-year-old girl ran ahead to press the button for the automatic elevator as her babysitter prepared to leave;
- The elevator arrived at the fourth-floor and the outside door opened. The girl was caught between the inner grill and outer door, which closed behind her;
- Somebody pressed the button on another floor and the young girl was crushed to death.[1]

1961: Seven-year-old boy died, crushed when he became wedged between the elevator door and the gate
[redacted] New Jersey

- The seven-year-old boy who may have been playing or hiding from a playmate when the incident occurred, became wedged between the elevator door and the gate;
- The boy's body was found wedged in the space between the door and the gate of the elevator, which was stuck between the third and fourth floors of the apartment building.[2]

1962: Three-year-old girl died, caught between the wall and the moving elevator
[redacted] New York

- Three-year-old girl was crushed to death between the wall and the moving elevator;
- Police said the victim somehow managed to get the inner door open and took hold the fourth-floor outer door as the self-service elevator descended in a [redacted] apartment. [3,4]

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[1] Charleston Daily Mail, Thursday, May 8, 1958, Page 1; http://newspaperarchive.com/us/west-virginia/charleston/charleston-daily-mail/1958/05-08/
[2] Red Bank Register, Tuesday September 5, 196; http://209.212.22.88/data/rbr/1960-1969/1961/1961.09.05.pdf (Page 2)
[3] Manitowoc Herald Times, Thursday, May 24, 1962, Page 17; http://newspaperarchive.com/us/wisconsin/manitowoc/manitowoc-herald-times/1962/05-24/page-17
[4] Toledo Blade, May 23, 1962; http://news.google.com/newspapers?nid=1350&dat=19620523&id=RbxOAAAAIBAJ&sjid=MgEEAAAAIBAJ&pg=6627,511812

1976: Seven-year-old boy died, trapped between the outer door and the wall of the elevator shaft
[redacted] New Jersey

- The seven-year-old boy became trapped in the building's elevator between its outer door and the wall of the elevator shaft;
- The elevator was activated and the boy was dragged up to the third floor;
- Another child who was racing up a nearby stairway to beat the elevator opened it, saw the victim wedged within it, and ran to seek help;
- Rescue workers worked for four and one-half hours to free the child; he died while still trapped.[5]

1977: Ten-year-old girl; crushed in an elevator between the hoist way door and the gate
[redacted] New York

- Ten-year-old girl was crushed in an elevator between the hoistway door and the gate.[6]

1980: Seven-year-old boy sustained broken leg, bruising and scarring
[redacted] New Jersey

- The seven-year-old boy was getting out of the elevator at a basement landing when he found himself trapped as the car gate closed behind him and the hoistway door was not open;
- Someone else called the car, and it ascended with the young boy stuck between the car gate and hoistway door. [7]

1986: 12-year old boy died, trapped between elevator door and swing gate
[redacted] New Jersey

- The 12-year-old boy became wedged between the swing hatch door and the elevator car gate;
- The elevator received an up call and traveled away from the basement landing, crushing the child between the wall immediately above the basement door header and the 2nd landing sill and leading edge of platform with toe guard. [8]

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[5] Portee v. Jaffee | Leagle.com; http://leagle.com/decision/198017284NJ88_1169.xml/PORTEE%20v.%20JAFFEE
[6] The Herald Statesman, August 20, 1978; http://fultonhistory.com/newspaper%2010/Yonkers%20NY%20Herald%20Statesman/Yonkers%20NY%20Herald%20Statesman%201978%20Grayscale/Yonkers%20NY%20Herald%20Statesman%201978%20Grayscale%20-%206052.pdf
[7] Liberty Mutual, accident report, December 9, 1980
[8] Otis Elevator company, accident report, April 14, 1987

1997: Four-year old girl died, caught between floors in a residential elevator [redacted] Illinois

- Four-year-old girl was caught between the floors of an elevator in a residential building;
- Her mother had gotten off before her and the other children pressed the call button.[9]

2001: Eight year-old boy died, entrapped between swing door of residential elevator [redacted] Maine

- The 8-year-old boy pushed the call button and opened the swinging door; the door closed behind the boy; before he could open the collapsible gate a maid on the second floor pushed the call button, interlocking the outer door and trapping the child in the gap between the outer swing door and collapsible gate;
- The young boy was nearly decapitated and died in front of his family;
- The distance between the outer swing door and collapsible gate was seven inches.
- Otis settled and sent notices to the elevator industry about the hazard. [10,11]

2002: Two sisters, ages six and seven died, heads crushed in residential elevator [redacted] New Jersey

- Two girls were lying down in the elevator with their heads partly across the threshold as the car rose;
- The safety feature was disabled allowing it to descend while the girls' heads stuck out past the gate;
- They died when their heads were wedged against part of the shaft. [12]

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[9] CPWR Deaths and Injuries Involving Elevators and Escalators, September 2013; http://www.cpwr.com/sites/default/files/publications/elevator_escalator_BLSapproved_2.pdf (Page 23)
[10] Space Between Swing Doors Collapsible Gates Still A Hazard; Lou Bialy; Elevator World; May 2003
[11] Terry Garmey Speaks About Tucker Smith and the Campaign to Repair 4,000 Guards on OTIS Elevators; Smith Elliott Smith & Garmey; http://www.fairwarning.org/wp-content/uploads/2013/12/TuckerSmithArticle.pdf
[12] Asbury Park Press, August 2, 2002; http://house.michigan.gov/sessiondocs/2013-2014/testimony/Committee238-9-24-2013.pdf

2003: Ten-year-old boy died, entrapped and crushed in swing door of residential elevator equipped with an accordion door
[redacted] Michigan

- The ten-year-old boy got caught between the hoistway door and the accordion door;
- The elevator started going down crushing the boy who then suffocated;
- The distance to the peak of the accordion door was approximately 5", but valleys were much deeper;
- The family's expert notified ASME A17 Residence Elevator Committee of this incident in 2006 .[13]

2004: Five-year-old boy died, crushed between elevator door and hoistway door
[redacted] Texas

- The five-year-old boy entered the elevator with his two-year-old brother in their family's multistory condominium;
- The accordion-style gate was not closed, allowing the boy's body to be extended outside the door as the elevator started moving up;
- As the elevator ascended, his head was crushed by the second floor landing. [14, 15]

2006: Eleven-year-old girl died, entrapped between the elevator and shaft walls
[redacted] North Carolina

- The 11-year-old girl was thought to have entered and exited the elevator with another child;
- The owner of the residence went to use the elevator and was unable to open the door;
- The fire department was notified and upon responding and opening the downstairs elevator found the girl pinned in the elevator shaft between the elevator and shaft walls. [16]

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[13] ASME A17 Residence elevator committee 2006 meeting minutes
[14] The Dallas Morning News, Sunday June 20, 2004, Page 3B;
http://newspaperarchive.com/us/texas/harlingen/valley-morning-star/2004/06-20/page-3
[15] The Dallas Morning News, Saturday June 19, 2004, Page 2B;
[16] Caroline Beach Police Department, North Carolina, Incident/Investigation report July 23, 2006

2009: Nine-year-old boy died, pinned in an elevator shaft between the wall and the door
[redacted] Kentucky

- A nine-year-old boy attending his grandmother's wedding ceremony died when he became pinned in a church elevator shaft;
- He wandered off by himself and was riding the elevator in the church sanctuary between the first and second floors;
- He became pinned between the elevator and the wall; there were no witnesses.[17]

2010: Three-year-old boy suffered catastrophic brain injury, entrapped between hoistway door and accordion door
[redacted] Georgia

- The three-year-old boy was entrapped between the hoistway (exterior) door and elevator accordion door;
- After child closed the hoistway door, the door automatically locked by way of an interlock;
- When mother hit the call button from the 3rd floor, the child was trapped in this space; the elevator rose toward the third floor and then stopped and re-leveled;
- The child was crushed by the elevator when it re-leveled down to the second floor;
- The distance between the hoistway door to accordion door varied by nearly 3";
- 4.875" to tip of the accordion door / 7.5" to valley of the accordion door;
- Injuries are catastrophic and permanent. Child diagnosed with an anoxic brain injury due to deprivation of oxygen for an extended period of time; he cannot communicate with the outside world or move in any meaningful way;
- This incident was reported to the CPSC on December 7, 2012.[18]

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[17] Evansville Courier & Press, June 13,2009; http://www.courierpress.com/news/local-news/child-crushed-sturgis-ky-church-elevator
[18] Jacob Helvey, Elevator Incident report date, December 7, 2012; http://www.saferproducts.gov/ViewIncident/1289132

November 2013: Ten-year old boy suffered catastrophic brain injury and quadriplegia, entrapped and pinned under elevator car
[redacted] South Carolina

- Ten-year-old boy suffered a catastrophic brain injury when he became trapped in an Elmira residential elevator manufactured by Cambridge Elevating, Inc. out of Cambridge, Canada;
- As the elevator began to rise with the car gate open, the child peered over the edge of the car platform and down into the elevator shaft;
- As the car continued to rise, the child's head came into contact with the doorframe, pinning his head under the elevator car;
- The car continued to rise up to the third floor, where the child was found laying face down on the floor of the elevator car with his head and neck trapped under the car platform;
- The jaws of life were eventually required to rescue the child from the elevator;
- In addition to multiple fractures, he suffered catastrophic brain injury.[19]

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[19] Jordan Nelson Elevator Incident report date September 5, 2014; http://www.saferproducts.gov/ViewIncident/1427183

TAB B: Residential Elevator Door Entrapment-Related Deaths, Injuries, and Potential Injuries; January 1, 1981–November 10, 2016

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
BETHESDA, MD 20814

Memorandum

Date: February 2, 2017

TO : Vincent Amodeo
Residential Elevator Entrapments Project Manager
Division of Mechanical and Combustion Engineering
Directorate for Engineering Sciences

THROUGH: Kathleen Stralka
Associate Executive Director
Directorate for Epidemiology

Stephen Hanway
Division Director, Division of Hazard Analysis
Directorate for Epidemiology

FROM : Ted Yang
Division of Hazard Analysis
Directorate for Epidemiology

SUBJECT : Residential Elevator Door Entrapment-Related Deaths, Injuries, and Potential Injuries; January 1, 1981–November 10, 2016[8]

I. Introduction

This memorandum characterizes the number of incidents involving entrapments between fully closed car and hoistway doors of residential elevators, as described in the petition. According to the petition, there have been at least 55 child deaths, as well as many injuries, related to residential elevators since 1967.[9] The petitioners provided details on only 16 incidents, which occurred between 1958 and 2013. In 1981, ASME A17.1 changed the requirement for the gap between the car and hoistway doors from 4 inches to a maximum gap of 5 inches. Staff reviewed incident reports that might involve entrapments between fully closed residential elevator car and hoistway doors from January 1, 1981 to November 10, 2016, to identify incidents matching the scenario in the petition. An effort to estimate the national number of injuries resulting from residential elevator entrapments due to gaps between car and hoistway doors is based on National Electronic Injury Surveillance System (NEISS) records retrieved for residential elevator entrapment incidents from January 1, 1981 to December 31, 2015. After review of incidents from January 1, 1981 to November 10, 2016, an attempt to retrieve incidents before 1981 resulted in an incomplete data set, where no residential elevator incidents could be identified.

[8] This analysis was prepared by CPSC staff. It has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.
[9] Based on dates of their incident data cited elsewhere in the petition, staff believes the petitioners meant 1947.

A residential elevator, as defined in ASME A17.1-13 §1.3, is "a power passenger elevator that is limited in size, capacity, rise, and speed, and is installed in a private residence or in a multiple dwelling that leads to a private residence, provided the elevators are so installed that they are not accessible to the general public or to other occupants in the building."

II. Incident Data

a. CPSRMS Incident Data[10]

CPSC staff is aware of a total of eight (8) incidents from reports in CPSRMS, including five fatalities that might have involved residential elevator entrapments between fully closed car and hoistway doors occurring between January 1, 1981 and November 10, 2016. CPSRMS is an online system that maintains consumer-registered incidents and industry comments, which are recorded, verified, and updated. It consists of the Injury or Potential Injury Incident (IPII), In-Depth Investigation (INDP), and Death Certificates (DTHS) databases received and maintained by CPSC. This information is based on anecdotal data collected from reports of incidents received by the CPSC, and thus, the results do not constitute a statistical sample representing all entrapment injuries and fatalities related to residential elevators.

Fatalities
The five (5) individual residential elevator incidents that might involve fatal entrapments between car and hoistway doors between January 1, 1981 and November 10, 2016, included:

1. 8134046440: On 7/6/1981, a 5-year-old, caught and crushed between doors of elevator, suffered multiple skull fractures and fractured vertebrae.

2. 8446003547: On 7/18/1984, a 5-year-old caught between two elevator doors, suffered multiple severe injuries.

3. 8634025958: On 5/24/1986, a 9-year-old caught between elevator doors suffered asphyxia by compression of the chest, resulting in multiple fractures and internal injuries.

4. 8934020725: On 4/20/1989, a 3-year-old suffered traumatic asphyxia from compression of the chest by an elevator door.

5. 9541027660: On 12/25/1995, an elevator door crushed the chest of a 16-year-old, resulting in anoxic encephalopathy, with multiple complications.

[10] CPSC staff searched the following databases in CPSRMS: INDP file, IPII file, and the DTHS file. Reported deaths and incidents do not provide a complete count of all that occurred during this time period. However, reported deaths and incidents may provide a minimum number of deaths and incidents occurring during this period and illustrate the circumstances involved in the incidents related to residential elevator door entrapments.

Non-fatalities
Two (2) reported injuries and one (1) reported non-injury were associated with CPSRMS incidents in the period outlined above:

1. I12C0120A: On 12/24/2010, a 3-year-old became entrapped between the hoistway door and accordion door of an elevator on the second floor of a family three-story home, resulting in permanent brain damage.

2. 150928CCC3978: On 12/23/2014, a 5-year-old suffered a fractured hip bone after being trapped between the hoistway door and accordion door of an elevator at a vacation property.

3. 151209CCC1200: On 6/26/2015, catastrophic injury or death was averted when adults rescued a 5-year-old trapped between hoistway door and accordion door before the elevator rose to their floor in a vacation home.

Sample Incidents from the Petition
Appendix A of the petition provided details on sixteen (16) incidents that occurred between 1958 and 2013. However, staff review indicates that nine (9) of these incidents occurred in a nonresidential location, and four (4) incidents did not match the hazard scenario described in the petition. Two of the three remaining incidents were recorded by a CPSRMS incident report (I12C0120A and X9762214A). The incident detailed in I12C0120A describes an entrapment of a 3-year-old boy between the inner and outer doors of a residential elevator that resulted in catastrophic brain injuries. The fatal injury of a 4-year-old girl described in X9762214A may involve an entrapment of the type that is of concern to the petitioner; however, sufficient details to make that determination and to establish the location of the incident are not available. The remaining incident appears to have involved an entrapment between the inner and outer doors of an elevator that resulted in injuries to the leg of a 7-year-old boy; however, it is unknown whether the incident occurred in a residential elevator.

b. CPSRMS Hazard Pattern Analysis

CPSC staff considered all eight incidents based on reports in IPII, INDP, and DTHS to identify hazard patterns associated with residential elevator doors. In three (3) nonfatal reported incidents, entrapments occurred in the space between the fully closed hoistway and accordion-style car doors. In the five (5) fatal reported incidents, there is insufficient detail to determine whether an entrapment between fully closed car and hoistway doors, as described by the petitioners, occurred.

c. NEISS Data

NEISS, a national stratified probability sample of emergency departments in the United States, and its territories, provides the data to generate national estimates of emergency department-treated injuries related to consumer products. There are five strata in the NEISS: children's hospitals, small hospitals, medium hospitals, large hospitals, and very large hospitals. Within

each stratum is a sample of hospitals that make up the primary sampling units (PSUs) of the NEISS. For each hospital in the sample, every first-time emergency department visit for an injury associated with a consumer product is recorded.[11] To facilitate injury estimates associated with a product or product group, each injury has a product code that identifies the type of product involved. Other product-specific information, such as the product manufacturer or events leading to the hazard, is not recorded in the NEISS. However, information that is recorded for each injury includes sex, age, diagnosis, disposition, and body part. Additional information about the NEISS can be found online at: http://www.cpsc.gov/en/Research--Statistics/NEISS-Injury-Data.

CPSC staff extracted NEISS records related to residential elevators under product codes 1814 "Elevators or other lifts (excluding farm elevators, forklifts and automotive lifts)" and 1889 "Elevators and other lifts (excluding escalators, hoists, jacks, forklifts and automotive lifts)," yielding a large initial data pool. Records describing elevator-related cases do not always clearly indicate an entrapment or a residential setting; therefore, staff reviewed the narratives of each case in this data pool and determined which cases were within the scope of this review – entrapment between the interior and elevator doors of residential elevators.

Although staff discovered 131 cases involving residential elevator door entrapments from January 1, 1981, to December 31, 2015, there was not enough information to determine if they were due to gaps between elevator car doors and elevator hoistway doors, as described in the petition, or due to some other reason. These cases either described incidents involving partial entrapments of various body appendages, but did not sufficiently illustrate a scenario where an entrapment between a fully closed car door and hoistway door could have happened. Consequently, there are an insufficient number of cases to generate a national estimate of emergency department-treated injuries associated with residential elevator door entrapments.[12]

[11] NEISS does not record return visits to the emergency department or other follow-up medical visits for the same injury.

[12] According to the NEISS publication criteria, an estimate must be 1,200 or greater, the sample size must be 20 or greater, and the coefficient of variation must be 33 percent or smaller.

TAB C: Market Information and Economic Considerations Related to Residential Elevator Petition

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: February 7, 2017

TO : Vincent Amodeo, Project Manager
Petition Requesting Rulemaking to for Residential Elevators
Directorate for Laboratory Sciences

THROUGH: Gregory Rodgers, Ph.D., Associate Executive Director
Directorate for Economic Analysis

Robert Franklin, Senior Staff Coordinator
Directorate for Economic Analysis

FROM : Samantha Li, Economist
Directorate for Economic Analysis

SUBJECT : Market Information and Economic Considerations Related to Residential Elevator Petition

Background

The Commission received a request to initiate rulemaking for residential elevators, and the Office of the General Counsel docketed the request as a petition (CP15-1). The petition asserts that in many home elevators, and in similar elevators found in older apartment and commercial buildings, the clearance between the fully closed interior door ("car door") and exterior door ("hoistway door") is large enough to allow children as old as 12 years to fit between the doors.[13] According to the petition, a child can become entrapped in this enclosed space when the elevator is called to another floor, and the hoistway door automatically locks. The child's body is carried along with the elevator car until it meets the obstruction of the sill, where the child's body─usually the head─is crushed.

Beginning on January 1, 1981 until December 2016, the voluntary standard (ASME A17) allowed a 5-inch gap between the car door and hoistway door. The petitioners assert that, in the case of an elevator car with an accordion door, this standard may have allowed up to 8 inches of space between the doors, if the distance is measured between the hoistway door and the furthest point on the car door (*i.e.*, the valley of the accordion door). The petitioners want the space

[13] The interior door is the car door or gate on the elevator car. In many residential elevators the car door is an accordion door. The exterior or hoistway door is the door through which the elevator is accessed. In many residential elevators this is a swing door.

between the hoistway and car door to be limited to no more than 4 inches when measured from the inside of the hoistway door to the farthest point on the car door (*i.e.*, the distance between the inside face of the hoistway door and the valley for an accordion door should not exceed 4 inches). The petitioners state that a mandatory standard is necessary to adequately reduce the entrapment hazard between the space of the car door and hoistway door.

In December 2016, the industry published a revised voluntary standard (ASME A17.1-2016) that includes provisions to limit the space between the hoistway door and car door. Staff believes these provisions address the petitioners' concern.

This memorandum provides information on the market for residential elevators and economic considerations. The discussion is based on information that was readily available, including information provided by the petitioners and public comments.

The Product

A residential elevator is comprised of hoisting and lowering mechanisms, a car, and a door that allows entry to and exit from the car at each level. The suspension and support cables are attached to the car frame. Residential elevators use one of four lift systems: hydraulic lift, winding drum, traction drive, and pneumatic. Hydraulic lifts operate by pump and cylinders. Winding drum and traction drive systems operate via pulleys, gears, and counterweights. Pneumatic lifts operate via air pressure, where the air pressure allows the elevator car to travel between floors.

The hoistway door is intended to keep occupants from falling into the elevator shaft when the car (or cab) is not present, and typically is not part of the elevator itself. The hoistway door automatically closes and locks when the elevator car is called to another floor. The hoistway door, which is usually a swing door in the case of residential elevators, can be designed to match the other doors in the home. Some residential elevators do not require a shaft or machine room.

The car door allows entry and exit to the car and acts as a barrier to prevent occupants from falling out of the car while the elevator is in motion. The elevator car moves in a vertical manner, *e.g.*, the elevator car covers the distance between landings. A car door can consist of either one or multiple panels. A single panel door moves horizontally, traversing the width of the doorway from left or right upon opening or closing. Two panel doors fold and move horizontally in the same manner as a single panel door or may open from each other at the center of the door frame. An elevator car can have up to three door openings. Car doors can be operated by manual or automatic gate openers.

Some elevator models use collapsible car doors, such as accordion-style gates. Gates may be composed of metal. The accordion gate collapses and folds to one side when the consumer pushes the gate to enter and exit the car.

Single-family home elevators are designed to travel shorter distances than elevators used in multi-story buildings. Residential elevators in single-family homes are generally designed to

travel up to 50 feet and service two or more landings (stops). Residential elevators range in size. The smallest can hold only one person comfortably, while the largest residential elevators are 15 square feet and can hold several people at once. On average, residential elevators can carry between 500 and 950 pounds. However, the smallest might have a maximum capacity as low as 375 pounds, and the largest might have a maximum capacity of up to 1,000 pounds. Elevators can be designed so that the interior of the car and passengers are visible when the car is traveling.

Market for Residential Elevators

Manufacturers

In the North American Industry Classification System (NAICS) residential elevator manufacturers are classified in category 333921 (Elevator and Moving Stairway Manufacturing). Based on 2012 Census data, there were approximately 170 firms in this category. However, this category also includes manufacturers of commercial and industrial elevators and escalators, and most of the manufacturers in this category do not manufacture residential elevators. EC staff identified at least seven firms that supply residential elevators in the United States.[14] Three are domestic manufacturers and four are foreign manufacturers who have dealers or distributors in the United States. All three domestic manufacturers have fewer than 500 employees and would be classified as a small business under the criteria established by the U.S. Small Business Administration (SBA).

Number in Use and Sales

In 2013, there were approximately 125,000 residential elevators in use. Additionally, approximately 5,000 are sold annually.[15] A major factor in a household's decision to add an elevator to a residence is the desire to stay in their homes as they age.[16] In 2013, the typical cost of a residential elevator ranged from $15,000 to $30,000.[17] Retrofitting elevators into existing homes is more expensive than installing the home at the time of manufacture. Once installed, an elevator's useful life can be expected to be the same as that of the house. [18]

Residential elevators are sold through dealers or retailer networks that are often affiliated with a manufacturer. The dealer usually arranges for the installation of the elevator. Elevator dealers or installers may be classified in the NAICS category 238290 (*Other Building Equipment*

[14] Hoistway doors are considered part of the residential unit. Manufacturers of hoistway doors are excluded from this analysis.
[15] Hubler, Shawn. "Elevator Safety Flaws Persist Despite History of Tragic Accidents." FairWarning.org. December 18, 2013. Available at: http://www.fairwarning.org/2013/12/elevator/.
[16] Weiker, Jim. "Getting a lift: Elevators on the rise in central Ohio homes," The Columbus Dispatch, March 29, 2015 (available at http://www.dispatch.com/content/stories/home_and_garden/2015/03/29/01-getting-a-lift.html) and Lauren Beale, "Popularity of home elevators gets a lift," The Los Angeles Times, February 13, 2013. Available at: http://articles.latimes.com/2013/feb/13/business/la-fi-home-elevators-20130213.
[17] "Home Elevator Prices for 2013." http://www.elevatordesigninfo.com/home-elevator-prices-for-2013.
[18] OTIS Safety Series #2: Swing Doors. OTIS Elevator Company. 2003. Available at: http://www.otis.com/site/ca-eng/OT_DL_Documents/OT_DL_SiteDocuments/BrochureforResidentialElevators.pdf.

Contractors). Based on 2012 Census data, there were approximately 5,800 firms in this category. More than 95 percent of these firms would be classified as a small business under the criteria established by SBA.[19] However, this is a very broad category and includes firms involved in installing gasoline pumps, satellite dishes, commercial doors, boilers and pipes, in addition to elevator installation. It is probable that most firms in this NAICS category are not involved in installing residential elevators.

Installation of Elevators in Homes

Hoistway doors generally are not manufactured or installed by the elevator manufacturer. Elevator dealers or installers work with home remodeling contractors (if the elevator is being retrofitted into an existing home) and home builders (if the elevator is being installed in new construction) to design and build the hoistway or shaft in which the elevator will be installed. The contractor involved in building or modifying the house to accommodate the elevator hoistway or shaft would be responsible for building or installing the hoistway door and sill. Typically, the residential elevator hoistway door matches the other internal doors in the house.

According to an elevator dealer sales representative, the hoistway door on most residential elevators (possibly around 90 percent) is a swing-door. Staff does not have any information on the number of swing-door elevators in use in which the gap between the elevator car door and the hoistway door is greater than 5 inches.

The National Association of Elevator Contractors (NAEC) and National Association of Elevator Safety Authorities (NAESA) both provide education, training, and certification programs for residential elevator installation and inspection.[20] NAEC represents independent elevator contractors and suppliers of products and services. NAESA members are comprised of elevator inspectors, mechanics, consultants, contractors, architects, engineers, elevator manufacturers and others interested in elevator safety, code enforcement, and technology. NAEC refers to A17.1 as a reference document to determine compliance for residential elevators. Thus, elevator inspectors are aware of the requirements in the voluntary standard.[21] According to an elevator dealer sales representative, elevator installers are often aware of building codes and other requirements, including the minimum space between the hoistway door and elevator car door or gate; and if a problem is noticed, elevator inspectors will frequently leave an elevator inoperable until the problem is fixed.[22]

[19] Under SBA guidelines, a manufacturer is considered small if it employs 500 or fewer employees.
[20] See http://naec.org/about-naec/ and https://www.naesai.org/qei-certification for more information on elevator certification programs, e.g., certification for elevator technicians, residential elevator lift technicians, and Qualified Elevator Inspectors.
[21] See https://www.naesai.org/qei-certification for additional information about QEI certification.
[22] Based on January 14, 2016 phone conversation with Area Access sales representative.

Existing Safety Standards for Residential Elevators

Voluntary Standard

Residential elevators are covered under the voluntary standard, ASME A17.1, Safety Code for Elevators and Escalators. The revised standard, ASME A17.1-2016/CSA B44-16, was published in December 2016. The standard requires the distance between the face of the hoistway door and the hoistway edge of the landing sill not to exceed 0.75 inches for swinging doors. In addition, the distance between the face of the hoistway door and car door shall not exceed 4 inches. The previous version of the standard allowed the distance between the face of the hoistway door and the hoistway edge of the landing sill to be up to 3 inches and the distance between the face of the hoistway door and car door to be up to 5 inches. In the industry, these distances are referred to as "3 x 5" rule.

Building Codes

Almost all state building codes reference ASME A17.1, though most do not reference the latest revision. Some state building codes require the distance between the elevator car door and the hoistway door to be less than the 4 inches required in the 2016 revision of the voluntary standard. For example, the Georgia residential building code, effective 2015, amended the requirements of ASME A17.1 by stating: "The clearance between the hoistway doors or gates and the hoistway edge of the landing sill shall not exceed 3/4 inch (19 mm). The distance between the face of the landing door or gate and the car door or gate shall not exceed 3 inches (75 mm)."[23]

Industry Efforts to Address Residential Elevator Safety

Several trade associations and other firms involved in the manufacture and installation of residential elevators participate in The HomeSafe Campaign (HomeSafe), which provides homeowners, manufacturers, and installers with information on how to install, operate, and maintain their home elevators safely. The participants in this campaign include Association of Members of the Accessibility Equipment Industry (AEMA), National Association of Elevator Contractors (NAEC), National Association of Elevator Safety Authorities International (NAESA), and ThyssenKrupp Access Corp.

HomeSafe suggests purchasing elevators with certain features if there are children in the household. HomeSafe recommends space guards or special hoistway doors that reduce the space between the elevator door and the hoistway door. Retail price for one space guard is approximately $90.[24] OTIS Elevator Company provided a similar retrofit product as part of a

[23] Georgia State Amendments to the International Residential Code for One- and Two Family Dwellings. Revised January 2015. Available at: http://www.dca.ga.gov/development/constructioncodes/programs/documents/IRC_Amendments_2015_effective.pdf

[24] The retrofit product is designed for use with ThyssenKrupp Access, National Wheel-O-Vator, or Access Industries home elevators. The retailer suggests contacting the elevator manufacturer if the consumer wants to use the product with an elevator model not listed above. http://elevatorspaceguard.com/.

2003 agreement to settle a lawsuit.[25] In addition to safety guards, OTIS also provided brochures and information highlighting the dangers specific to residential swing-doors.[26]

HomeSafe recommends that residential elevators include:

- Hoistway doors with interlocks, which prevent the hoistway door from being opened unless the car is at that landing and prevent the cab from leaving the landing unless the door is closed and locked.
- Car door or gate safety switch to prevent the cab from moving unless the cab door or gate is in the closed position and to stop the cab if the cab door or gate is opened during travel.
- Cab safety devices to stop the cab in the unlikely event the cab suspension means fail.
- Emergency stop switch in the cab to stop the cab if necessary during travel.
- Emergency signaling devices in the cab (alarm and phone) to signal if help is needed.
- Terminal and final limit switches to prevent the cab from over-travelling past the upper- and lower-most stops.
- Certified electrical control system to monitor all safety functions and ensure these functions are operating properly before allowing the elevator cab to move.
- Additional safety features may be provided depending on the type of elevator and drive system used. These include, the following:
    - Over speed governor to monitor cab speed and stop the cab if it moves too rapidly.
    - Buffers to protect the passengers, cab, and others in the unlikely event of a fall.
    - Flow control valve in the event of a hydraulic oil line failure.
- Light curtains that detect someone in the space between doors, and key locks and door locks to prevent children from potentially getting stuck or injured in a home elevator.[27]

The HomeSafe Campaign recommends that only professional and licensed persons install and inspect home elevators and perform all required maintenance, service, or repair work. Mechanics and installers should be trained and licensed or recognized by an authority having jurisdiction in the local area.[28]

Some firms offer additional safety features to prevent child entrapment. For example, one firm provides an alternative to accordion doors: the firm's "child safe" doors consist of several rigid panels that traverse the width of the door opening. Another firm provides a "child safe gate" that allows the elevator to operate only after the gate is secured and can reduce the distance between the hoistway door and car door to "as little as ¾ inch."

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[25] "OTIS Elevator agrees to Safety Campaign." The Associated Press. Bangor Daily News. Jan 10, 2003. Available at: https://news.google.com/newspapers?nid=2457&dat=20030110&id=8aFJAAAAIBAJ&sjid=UA0NAAAAIBAJ&pg=4146,2103577&hl=en.

[26] Safety guard brochures can be accessed online at: http://www.otis.com/site/ca-eng/Pages/NationalSafetyProgram.aspx , http://www.otis.com/site/ca-eng/OT_DL_Documents/OT_DL_SiteDocuments/BrochureforResidentialElevators.pdf and http://www.otis.com/site/ca-eng/Pages/NationalSafetyProgram.aspx.

[27] Home Safe Campaign information can be found online at: http://homesafecampaign.com/know-the-safety-features-of-your-home-elevator/.

[28] See http://homesafecampaign.com/faqs/ for additional information about the safety campaign.

Societal Costs

The Directorate for Epidemiology identified fatalities that might have involved entrapment between an elevator car door and the hoistway door. However, there were insufficient details to determine whether entrapment between a fully closed car door and hoistway door was, in fact, the cause of deaths. Similarly, the Directorate for Epidemiology was unable to estimate the number of nonfatal injuries that would be addressed by the petition because there was not enough information available in the NEISS records to determine if these cases were due to gaps between elevator car doors and elevator hoistway doors, as described in the petition. Because there is insufficient information to determine the number of deaths or to estimate the number of injuries associated with this hazard, staff cannot estimate the societal costs associated with this hazard.

Summary

The petition seeks a rule to limit the distance between the inside of the hoistway door and the valley for an accordion door to no more than 4 inches measured from any point. The estimated number of home elevators in use is approximately 125,000, and approximately 5,000 are sold annually. About 90 percent of residential elevators could have accordion car doors and swing hoistway doors. A new version of the voluntary standard, ASME 17.1, was published in December 2016, and limits the space between the car door and hoistway door to no more than 4 inches. The voluntary standard applies to elevators manufactured and installed after June 2017.

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TAB D: Human Factors Assessment for the Residential Elevator Petition

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

MEMORANDUM

DATE: January 12, 2017

TO: Vincent J. Amodeo, Project Manager, Residential Elevator Petition
Division of Mechanical Engineering, Directorate for Laboratory Sciences

THROUGH: Joel R. Recht, Ph.D., Associate Executive Director,
Directorate for Engineering Sciences

Rana Balci-Sinha, Ph.D., Director,
Division of Human Factors, Directorate for Engineering Sciences

FROM: Timothy P. Smith, Senior Human Factors Engineer,
Division of Human Factors, Directorate for Engineering Sciences

SUBJECT: Human Factors Assessment for the Residential Elevator Petition

BACKGROUND

On November 1, 2013, The Safety Institute, Carol Pollack-Nelson, and Cash, Krugler & Fredericks, LLC (collectively referred to as the petitioners), submitted a petition (CP 15-1) to the U.S. Consumer Product Safety Commission (CPSC or Commission) to initiate rulemaking to mandate a safety standard for residential elevators to address an entrapment hazard caused by the space between the interior elevator car door or gate (car door) and the exterior elevator access door or landing door (hoistway door) for the residence or building. The petitioners assert that in many home elevators, and in similar versions found in older apartment and commercial buildings, the clearance between the car door and hoistway door is large enough to allow children as old as 12 years to fit between the doors. According to the petitioners, a child can become entrapped in this space when the elevator is called to another floor, and the hoistway door automatically locks. In this scenario, the child's body is carried along with the elevator car until the hoistway door meets the obstruction of the sill, where the child's head or body is crushed.

The petitioners request that CPSC promulgate a mandatory standard that constrains the space between residential elevator hoistway doors and car doors to 4 inches, when measured from the inside of the hoistway door to the farthest point on the car door. Since the petition was docketed, ASME A17.1, *Safety Code for Elevators and Escalators*, was revised to reduce the permissible clearance between the hoistway and car doors from 5 inches to either 4 inches, or a distance that would reject a 4-inch diameter ball, depending on the specific door combination in use. This memorandum, prepared by staff of CPSC's Directorate for Engineering Sciences, Division of Human Factors (ESHF), discusses the extent to which a maximum space of 4 inches, as requested by the petitioner and as reflected by the latest revisions to ASME A17.1, would address the purported hazard, based on available incident and child anthropometric data.

DISCUSSION

INCIDENT DATA

Staff of CPSC's Directorate for Epidemiology, Division of Hazard Analysis (EPHA), has identified eight reported incidents involving entrapments between residential elevator doors occurring between January 1, 1981 and November 10, 2016 (see Tab B). Five of the eight incidents were fatalities, and two resulted in injury; the remaining incident did not result in injury. The reported fatalities and injuries involved children as young as 3 years. Although most of the reported incidents did not include enough information to determine the source of the entrapment, three reported incidents—all non-fatalities—involved gaps between accordion-style car doors and hoistway doors, and appear to reflect the hazard pattern identified in the petition.

EPHA staff also searched the National Electronic Injury Surveillance System (NEISS) and identified 131 cases involving entrapments between residential elevator doors from January 1, 1981 and December 31, 2015. ESHF staff's examination of the cases found that they involved children as young as 11 months. Although the narratives associated with these cases are very brief, most appear to involve hand and finger entrapments in elevator doors, rather than the specific hazard scenario identified by the petitioners. Nevertheless, the cases do provide some insight into the lower age range of children who might be exposed to the hazard of interest to the petitioner.

ASME A17.1 REQUIREMENTS AND REVISIONS

The 2013 version of ASME A17.1, *Safety Code for Elevators and Escalators*, includes a requirement for the distance between the hoistway door and the car door not to exceed 5 inches. Specifically, section 5.3.1.7.2 of ASME A17.1 – 2013 states, in part, "The distance between the hoistway face of the landing door or gate and the car door gate shall not exceed 125 mm (5 in.)." As detailed by staff of CPSC's Directorate for Engineering Sciences, Division of Mechanical and Combustion Engineering (ESMC), the 2016 version of the standard includes revisions that limit this distance to: (1) not exceed 4 inches, or (2) reject a 4-inch diameter ball (see Tab E). Whether this requirement is met by a 4-inch or smaller measurement or by the rejection of a 4-inch diameter ball depends on the specific types of hoistway and car doors in use.[29] However, the overall effect is the same: a rigid object larger than 4 inches in all dimensions would no longer fit in the space between the hoistway and car doors.

EFFECTIVENESS OF 4-INCH REQUIREMENT

Young children are known to have heads that are larger proportionally than their adult counterparts, relative to overall body size, and head size is often the determinant of whether a

[29] For example, "power-operated horizontally sliding hoistway and car doors" and "swinging hoistway doors and power-operated horizontally sliding car doors" are assessed by taking a measurement; however, "swinging hoistway doors and folding car doors," "swinging hoistway doors and car gates," and "swinging or horizontally sliding hoistway doors and manually operated horizontally sliding car doors" are assessed with a 4-inch diameter ball (see ASME A17.1 – 2016, section 5.3.1.8.3).

young child's body can pass entirely through an opening. Consequently, young children are particularly susceptible to feet-first entrapment within bounded openings. In a feet-first entrapment scenario, the child enters a fully bounded opening that is large enough to admit the torso, but is not large enough for the head to pass through. Similarly, for small, at-risk children, head size would likely be the limiting factor or dimension that would determine whether the child could fit within the available space between the closed hoistway and car doors of a residential elevator. Because head widths generally are narrower than head lengths, the worst-case scenario would involve a child standing within this space with the head turned sideways. If the width of a child's head is larger than the available space, then the doors cannot close completely, which would prevent the hazard scenario.

Few anthropometric data sources include detailed head measurements for children; however, Snyder and colleagues (1977) include data on maximum head breadth, which is the maximum width of the head (*i.e.*, the horizontal distance from one side of the head to the other) above and behind the ears. Four inches is smaller than the maximum head breadths of virtually all children examined in that study. For example, the minimum and 5th percentile values for children ages 2.0 to 3.5 years—the age range encompassing the youngest known victims of the hazard scenario identified by the petitioners—are 11.9 cm (4.7 inches) and 12.5 cm (4.9 inches), respectively. These data are generally consistent with other limited head breadth data available for children in this approximate age range.[30]

Even if one were to consider younger potential victims, available anthropometric data suggest that limiting the space between the elevator car and hoistway door to 4 inches effectively addresses the hazard. Based on data reported by Snyder and colleagues (1977), only the smallest of the youngest infants are likely to have head breadths smaller than 4 inches. For example, the minimum and 5th percentile values for infants age 0.0 to 2.0 *months* are 9.5 cm (3.7 inches) and 9.6 cm (3.8 inches), respectively; however, the average head breadth for this age group exceeds 4 inches (10.4 cm, or 4.1 inches), and even the minimum reported value for infants age 3.0 to 5.0 months is larger than 4 inches (10.4 cm, or 4.1 inches). Again, these data are generally consistent with other head breadth data available for children in the same approximate age ranges.[31]

The ASME voluntary standard's use of a 4-inch diameter ball, rather than a 4-inch measurement, is especially useful for elevators with accordion-style car doors because this approach avoids possible confusion about whether the measurement should be taken at the folds of the car door that are closest to or furthest from the hoistway door. In addition, this approach allows one to

[30] For example, Schneider and colleagues (1986) report the smallest (minimum) maximum head breadth for children 25 to 36 months old to be 12.3 cm (4.8 inches). Steenbekkers (1993 as cited in Norris & Wilson, 1995) report the 5th percentile head breadth for 2-year-old males and females in The Netherlands to be 12.5 cm (4.9 inches) and 12.0 cm (4.7 inches), respectively.

[31] Schneider and colleagues (1986) report the smallest (minimum) maximum head breadth for children 0 to 3 months old to be 10.0 cm (3.9 inches); for children 4 to 6 months old, this value is reported to be 10.5 cm (4.1 inches). Steenbekkers (1993 as cited in Norris & Wilson, 1995) report the 5th percentile head breadth for 0- to 2-month-old males and females in The Netherlands to be 8.9 cm (3.5 inches) and 9.3 cm (3.7 inches), respectively; the 5th percentile head breadth for 3- to 5-month-old males and females were reported to be 9.9 cm and 10.0 cm (about 3.9 inches), respectively, and the 5th percentile head breadth for 6- to 8-month-old males and females were reported to be 11.0 cm and 10.9 cm (about 4.3 inches), respectively.

assess whether something 4 inches in diameter could fit into the V-like spaces that accordion-style car doors can create, regardless of the measured horizontal distance between the car door track and the hoistway door.

CONCLUSION

Based on the available incident and anthropometric data, ESHF staff concludes that requiring a maximum space of 4 inches between the elevator car and hoistway door effectively addresses the hazard identified in the petition. The only children who would likely fit completely within this space would be the smallest of the youngest infants (*e.g.*, small newborns). These children are not known to be, and are highly unlikely to be, involved in the hazard scenario identified in the petition.

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Snyder, R., Schneider, L., Owings, C., Reynolds, H., Golomb, D., & Schork, M. (1977). *Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design*. Report No. UM-HSRI-BI-77-17. Ann Arbor, Michigan: The University of Michigan, Highway Safety Research Institute.

TAB E: Assessment of Existing Standards and Practices Related to Residential Elevators

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MARYLAND 20814

Date: February 13, 2017

TO : Residential Elevator Petition File
Directorate for Engineering Sciences

THROUGH : Mark Kumagai
Director, Division of Mechanical and Combustion Engineering
Directorate for Engineering Sciences

FROM : Vincent J. Amodeo
Mechanical Engineer
Directorate for Engineering Sciences

SUBJECT : Assessment of Existing Standards and Practices Related to Residential Elevators

I. Introduction and Background

On November 1, 2013, the Safety Institute, Carol Pollack-Nelson, and Cash, Krugler & Fredericks (the petitioners) petitioned the Consumer Product Safety Commission (CPSC, or Commission) to initiate mandatory rulemaking to set safety standards for the design and installation of residential elevators to eliminate excessive space between the elevator car door/gate (car door) and the hoistway or swing door (hoistway door) (TAB A). The petitioners request that the rule constrain the space between the car door and hoistway door to no more than 4 inches when measured from the inside of the hoistway door to the farthest point on the car door. On January 22, 2015, the Office of the General Counsel docketed the request for rulemaking as Petition CP 15-1 (80 FR 3226) under the Consumer Product Safety Act (CPSA).

The petitioners state that the space between the elevator car and hoistway doors in many residential home elevators, and similar elevators found in apartment and commercial buildings, is large enough to allow children up to 12 years of age to fully fit between the closed doors. If the child becomes trapped in the space when the elevator is called to another floor, the child is dragged inside the hoistway until the child's body is crushed against the next floor's sill.

The petitioners state that there have been at least 55 child deaths related to residential elevators since 1967 (based on dates of their incident data cited elsewhere in the petition; staff believes the petitioners meant 1947), as well as many injuries, and provided details on 16 incidents that occurred between 1958 and 2013, in which a child was purported to have been injured or killed while entrapped in the subject space in a residential elevator. However, a review by CPSC staff (TAB B) indicates that many of the 16 incidents did not involve residential elevators or were not related to the entrapment hazard identified by the petitioner, and the cause could not be determined in some incidents.

The petitioners state that the elevator industry has not modified the relevant requirement for

residential elevators, Section 5.3, in the voluntary standard, American Society of Mechanical Engineers (ASME) A17.1 *Safety Code for Elevators and Escalators* to address the hazard. At the time the petition was filed, Section 5.3.1.7.2 in ASME A17.1 allowed a gap of up to 5 inches between the residential elevator car door and hoistway door. The petitioners cited numerous ASME A17 subcommittee efforts since 2005 to reduce the clearance between the elevator car and hoistway doors in the voluntary standard from 5 inches to 4 inches, but each effort failed to pass. In addition, the petitioners believed compliance with an amended ASME A17.1 would be low because jurisdictions are not required to adopt the latest version of the A17.1 Elevator Safety Code. Therefore, the petitioners believe mandatory rulemaking is required to address the child entrapment hazard in residential elevators.

This memorandum provides an assessment of the existing standard related to residential elevators, ASME A17.1 *Safety Code for Elevators and Escalators*.

II. Product Description

ASME A17.1 defines "residential elevators" as elevators that are installed in or at private residences or in buildings providing access to a private residence provided the elevators are not accessible to the general public. Figure 1 shows a typical residential elevator installation.

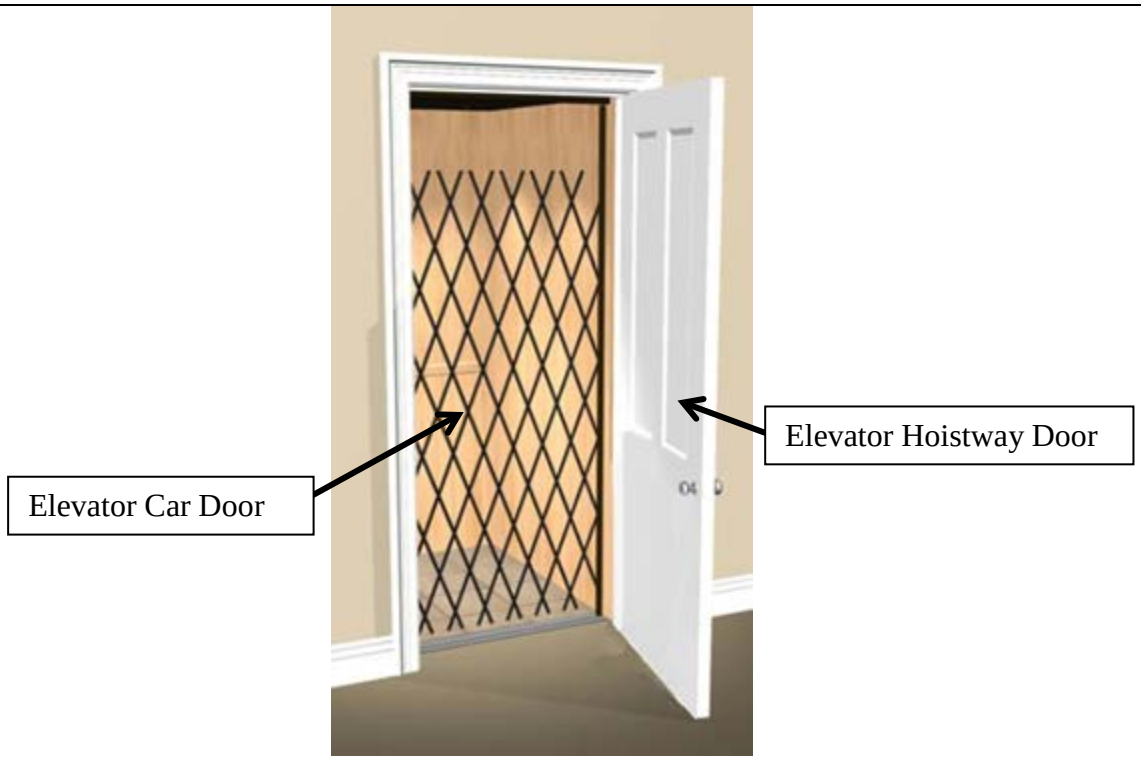

Figure 1. Typical Residential Elevator

The hoistway (or shaft) in which the elevator moves is usually solidly enclosed throughout its height, except for hoistway doors at each landing access. Hoistway doors can be swinging or horizontally sliding doors or gates. Interlocks are installed to prevent the elevator car from moving unless all doors are closed and locked. Hoistway and car doors may be power-operated or manual. A typical residential elevator with a swinging exterior door and an accordion-style interior door is shown in Figure 2. The hazard scenario can occur when a child becomes entrapped between the fully closed interior car door and the closed exterior hoistway door as shown in Figure 3. If a child is entrapped and the elevator is called to a different landing, the child becomes wedged between the moving elevator car and the stationary hoistway door and frame.

Figure 2. Typical Residential Elevator with Swinging Hoistway Door and Accordion Car Door

III. Voluntary Standard

History

The applicable voluntary standard for residential elevators is ASME A17.1, *Safety Code for Elevators and Escalators,* which specifies requirements for elevators, escalators, dumbwaiters, moving walks, material lifts, and dumbwaiters with automatic transfer devices. The standard was first published in 1921, and first included requirements for residential elevators in 1955. At the time the petition was submitted on November 1, 2013, the standard specified a maximum sill depth of 3 inches and a distance of 5 inches between the hoistway faces of the residential elevator car and hoistway doors.

Requirements for residential elevators are covered in ASME A17.1 section 5.3, *Private Residence Elevators*. Section 5.3 applies to "elevators installed in or at a private residence … (and) similar elevators installed in buildings as a means of access to private residences within such buildings provided the elevators are so installed that they are not accessible to the general public or to other occupants in the building."

Section 5.3.1.7.2 of the 2013 version allowed a gap of up to 5 inches between the hoistway face of the car and hoistway doors. An overhead view of a typical door interface is shown in Figure 3. The blue figure shows the relevant gap in which child could become entrapped between closed doors.

> 5.3.1.7.2 **Clearance Between Hoistway Doors or Gates and landing Sills and Car Doors and Gates**. The clearance between the hoistway doors or gates and the hoistway edge of the landing sill shall not exceed 75 mm (3 in.). The distance between the hoistway face of the landing door or gate and the car door (or) gate shall not exceed 125 mm (5 in.).

Staff assessed that the 2013 version requirements and found three concerns relative to the entrapment hazard presented by the petition:

1. A 5-inch dimension exceeds the head breadths of small at-risk children (see Tab D).
2. There is no requirement for how the dimension is measured. The prevalent use of accordion-style car doors could allow for gaps greater than 5 inches when measured between the "Vs" of the interior door and the exterior door. Such large spaces increase the risk that children can fit and become trapped. The petitioners claim that such spaces could trap children up to 12 years of age.
3. There is no requirement for the rigidity of the car and hoistway doors. Thus, if either door can deform with minimal force, it can create a gap greater than 5 inches and permit older children to become trapped.

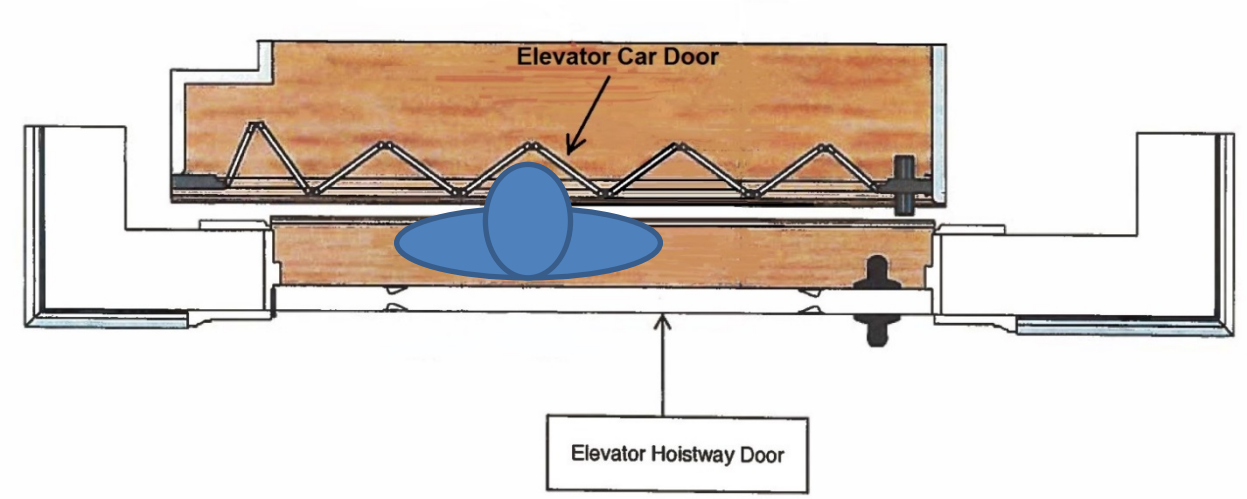

Figure 3. Typical Residential Elevator Overhead View

The ASME A17 standards committee attempted to address residential elevator entrapment hazards on several occasions. In 2005, the ASME A17 elevator committee discussed revisions to the clearance section of A17.1, and several members recommended a clearance of 4 inches between the car and hoistway doors. However, proposals to reduce the allowable clearance and to detail how the measurement was to be made were rejected. The 5-inch clearance between the car and hoistway doors remained in the 2013 edition of the standard.

Current Standard

In June 2013, ASME balloted several proposed revisions to A17.1-2013, which included a draft ballot for the residential elevators section 5.3 shown in Appendix A. The standards committee ballot was in January 2015. The changes were approved as balloted, and the revisions were included in the 21st edition of ASME A17.1, published on November 30, 2016.

ASME A17.1-2016 added section 5.3.1.8.3, which specifies the clearance between hoistway doors (exterior doors) and car doors or gates (interior doors). The new section breaks out the clearance requirements for five different car and hoistway door combinations:

a. *Power-operated horizontally sliding hoistway and car doors*. For this combination, the measurement of the leading edge of the doors shall not exceed 100 mm (4 in.).
b. *Swinging hoistway doors and folding car doors.* For this combination, when both doors are in the fully closed position, the space between the doors shall reject a 100 mm (4 in.) diameter ball at all points.
c. *Swinging hoistway doors and car gates.* For this combination, the space between the doors shall reject a 100 mm (4 in.) diameter ball at all points.
d. *Swinging hoistway doors and power-operated horizontally sliding car doors*. For this combination, where the car door(s) cannot be closed until after the hoistway door is closed, and the car door(s) automatically open when the car is at a landing and the hoistway door is opened, the measurement between the hoistway face of the hoistway

door and the hoistway face of the car door shall not exceed 100 mm (4 in.). Where either door can be disconnected from the operator (control) and then allow the user to operate the door manually, 5.3.1.8.3(e) shall apply.

e. *Swinging or horizontally sliding hoistway doors and manually operated horizontally sliding car doors*. For this combination, when both doors are in the fully closed position, the space between the doors shall reject a 100 mm (4 in.) diameter ball at all points.

ASME A17.1-2016 also added section 5.3.1.8.2 (d), which specifies the strength and deflection of doors, gates, and their guides, guide shoes, track, hangers. This section addresses the hazard of an entrapment space created between the hoistway door and elevator car door due to one or both doors deflecting and creating a hazardous gap.

1) Horizontal sliding car doors and gates when fully closed shall be designed and installed to withstand a force of 335 N (75 lbf) applied at any location on the door without exceeding a deflection of 19 mm (0.75 in.) and without permanent deformation.
2) Folding car doors when fully closed shall be designed and installed to withstand a force of 355 N (75 lbf) applied using a 100 mm (4 in.) diameter sphere at any location within the folds on the door without exceeding a deflection of 19 mm (0.75 in.) and without permanent deformation.

Additionally, ASME A17.1-2016 includes a revised section 5.3.1.7.2 to reduce the clearance distance between the hoistway face of the hoistway doors or gates and the hoistway edge of the landing sill. The revision specifies that this clearance shall not exceed 19 mm (0.75 in) for swinging doors and 57 mm (2.25 in.) for sliding doors.

ASME also has a standard for existing elevators, ASME A17.3-2015, *Safety Code for Existing Elevators and Escalators,* which is currently in the ballot process to require the same residential elevator door clearances and rigidity test method as required under ASME A17.1-2013. These changes would ensure that potential entrapment hazards on existing elevators will also be addressed. CPSC staff will continue to monitor ASME A17.3-2105 standard activities.

IV. Discussion

Staff reviewed the petitioners' recommendation that a mandatory rule for residential elevators be established to constrain the space between the car and hoistway doors to no more than 4 inches when measured from the inside of the hoistway door to the farthest point on the car door. Staff examined the potential hazard for entrapment and assessed the current voluntary standard to see if such a hazard would be addressed. Staff also reviewed whether: (i) compliance with an existing voluntary standard would eliminate or adequately reduce the risk of injury addressed and; (ii) whether it is likely that there will be substantial compliance with such voluntary standard.

The petitioners' request states that injuries and deaths occurred in the excess space between fully closed hoistway and car doors of residential elevators, due, in part, to the ASME standard in place at the time (ASME A17.1-2013), which allowed a gap of up to 5 inches between the hoistway face of the car and hoistway doors.

Staff believes that the revisions in ASME A17.1-2016 would adequately address the entrapment hazard for new residential elevator installations by: (1) specifying a clearance of no more than 4 inches between the elevator and car doors, (2) specifying a test method to determine the clearance is not exceeded, and (3) specifying the rigidity of the elevator doors. According to CPSC human factors staff (TAB D), limiting the dimension between the car and hoistway door to no more than 4 inches will prevent all but the smallest newborns from fitting completely within the space. This group is highly unlikely to be involved in the hazard scenario.

The 4-inch requirement addresses the hazardous 5-inch dimension between the hoistway and car door and exceeds the head breadths of small at-risk children by removing the potential for accordion-style car doors to create gaps greater than 4 inches when measured between the "Vs" of the interior door and the exterior door. The requirement specifying the rigidity of the car and hoistway doors ensures that the doors cannot become deformed with minimal force and create a gap greater than 4 inches. Staff believes the revisions in ASME A17.1-2016 would address the potential the hazard, because the only children who would likely fit completely within the 4-inch space would be the smallest of the youngest infants (*e.g.,* small newborns). No infants have been involved in the hazard scenario identified in the petition.

Staff believes most elevators installed after ASME A17.1-2016 becomes effective in May 2017 will meet the new requirements if state building codes are updated to require safety inspections that meet the ASME A17.1-2016 requirements by fall 2017. Staff reviewed the elevator building codes of all 50 states. Almost all the states reference ASME A17.1 in the state elevator building code requirements. However, many states need to update their references to the latest version of the standard on their website. The ASME A17 Committee has established the A17 Regulatory Authority Council, which facilitates the dissemination of the latest code changes to jurisdictional authorities. Staff will contact ASME to alert the state regulatory bodies that the newest version (2016) is available and should be reflected if the latest version is not indicated in the existing state code.

Staff believes that industry will be informed of the new standard requirements because the committee that developed the revised standard is comprised of elevator manufacturers and elevator installers. In addition, associations, such as NAEC, AEMA, and NAESA, promote the latest safety information to elevator manufacturers and installers through the HomeSafe Campaign (HomeSafe), which provides homeowners, manufacturers, and installers with information on how to install, operate, and maintain their home elevators safely. Membership in these organizations is comprised of elevator inspectors, mechanics, consultants, contractors, architects, engineers, elevator manufacturers and others interested in elevator safety, code enforcement, and technology. NAESA members include 328 contractors, 58 associate contractors, and 293 suppliers. Quality of Elevator Inspectors (QEI) certification is obtained

through NAESA and ASME A17.1 is listed as a required codebook for the exam, and the 2016 revision will become mandatory code for certification in fall 2017.

ASME also has a standard for existing elevators, ASME A17.3-2015, *Safety Code for Existing Elevators and Escalators,* which is currently in the ballot process to require the same residential elevator door clearances and rigidity test method as required under ASME A17.1-2013. These changes would ensure that potential entrapment hazards on existing elevators will also be addressed. CPSC staff will continue to monitor ASME A17.3-2105 standard activities.

V. Conclusion

Staff believes that the current edition of ASME A17.1-2016 addresses the petitioners' concern for new elevator installations: (1) specifying a clearance of no more than 4 inches between the elevator car and hoistway doors, (2) specifying a test method to determine the clearance is not exceeded, and (3) specifying the rigidity of the elevator doors. In addition, staff also finds that compliance with the voluntary standard would eliminate or adequately reduce the risk of injury addressed. Staff also believes that by working with the ASME A17.1 Committee to alert state regulatory bodies to update references to the current standard, substantial compliance to the voluntary standard will be more likely.

ASME 17.1 Draft Revision for Residential Elevators

Text to be deleted is crossed out. New text is underlined.

5.3.1.7 Protection of Hoistway Openings

5.3.1.7.1 ~~Where Required~~ Hoistway Enclosure Provided. Where a hoistway enclosure is ~~required~~ provided, landing openings shall be protected by swinging or horizontally sliding doors ~~or gates~~. Landing openings in solid hoistway enclosures shall be protected the full height by solid swinging or horizontally sliding doors. Their fire-protection rating shall be not less than required by the building code (see 1.3). The doors ~~or gates~~ shall be designed to withstand a force of 670 N (150 lbf) applied horizontally over an area 100 mm x 100 mm (4 in x 4 in.) in the center of the doors ~~or gates~~ without permanent displacement or deformation.

Rationale: Updated proposal to include hoistway doors whenever an enclosure is provided, not just when they are required. Removed hoistway gates to be consistent with other sections of the Standard.

5.3.1.7.2 Clearance Between Hoistway Doors ~~or Gates~~ and Landing Sills ~~and Car Doors or Gates~~. The ~~clearance~~ distance between the hoistway face of the hoistway doors ~~or gates~~ and the hoistway edge of the landing sill shall not exceed ~~75 mm (3 in.)~~ 19 mm (0.75 in) for swinging doors and 57 mm (2.25 in.) for sliding doors. ~~The distance between the hoistway face of the landing door or gate and the car door gate shall not exceed 125 mm (5 in.)~~

Rationale: Reduced clearance between hoistway door and edge of landing sill based on Hazard Analysis. Moved hoistway door to car door clearance to new section 5.3.1.8.3.

5.3.1.8.2 Car Doors and Gates. A car door or gate that, when closed, will guard the opening to a height of at least 1675 mm (66 in.) shall be provided at each entrance to the car. Car doors shall be permitted to be of solid or openwork construction that will reject a ball 75 mm (3 in.) in diameter. Collapsible car gates shall be of a design that, when fully closed (extended position), will reject a ball 75 mm (3 in.) in diameter.

a) *Power Operation of Car Doors and Gates.* Power opening shall be permitted for car doors and gates, and shall conform to 2.13.2.1 and 2.13.6. Power closing shall be permitted for car doors and gates, and shall conform to 2.13.3 through 2.13.6.
b) *Car Door or Gate Locking Devices.* Where the hoistway enclosure is not continuous for the full travel of the car, the car door or gate shall be provided with a mechanical lock that will lock the car door or gate if the car is more than 150 mm (6 in.) vertically away from a landing.
c) *Car Door or Gate Electric Contacts.* Every car door or gate shall be provided with an electric contact conforming to 2.14.4.2.3 and 2.14.4.2.5. The design of the car door or gate electric contacts shall be such that for a sliding door or gate, the car cannot move unless the door or gate is within 50 mm (2 in.) of the closed position. If the door or gate swings outward to open, the car door or gate must be closed and locked before the car can move.
d) **Strength and Deflection of Doors, Gates, and Their Guides, Guide Shoes, Track, and Hangers.**

1) Horizontal sliding car doors and gates shall be designed and installed to withstand a force of 335 N (75 lbf) applied horizontally on an area 100 mm by 100 mm (4 in. by 4 in.) at right angles to and at any location on the car door without permanent deformation. The deflection shall not exceed 19 mm (0.75 in.) and shall not displace the door from its guides or tracks. The force shall be applied while the door is in the fully closed position.
2) Folding car doors shall be designed and installed to withstand a force of 335 N (75 lbf) applied horizontally using a 100 mm (4 in.) diameter sphere at any location within the folds on the car door without permanent deformation. The deflection shall not exceed 19 mm (0.75 in.) and shall not displace the door from its guides or tracks. The force shall be applied while the door is in the fully closed position.

Rationale: To add strength and deflection requirements for car doors and gates on private residence elevators.

5.3.1.8.3 Clearance Between Hoistway Doors and Car Doors or Gates. The distance between the hoistway face of the landing door and the hoistway face of car door or gate shall conform to one of the following:

a) **Power Operated Horizontally Sliding Hoistway and Car Doors.** Where power operated horizontally sliding hoistway and car doors are used, the measurement between the leading edge of the doors or sight guard, if provided, shall not exceed 100 mm (4 inches). If it is possible for a user to detach or disconnect either door from the operator (such as in the event of operator failure) and such detachment or disconnection allows the user to operate the door manually, requirement 5.3.1.8.3(e) shall apply.
b) **Swinging Hoistway Doors and Folding Car Doors.** Where swinging hoistway doors and folding car doors are used and both doors are in the fully closed position, the space between the Hoistway door and the folding door shall reject a 100 mm (4 inch) diameter ball at all points.
c) **Swinging Hoistway Doors and Car Gates.** Where swinging hoistway doors and car gates are used, the space between the Hoistway door and the car gate shall reject a 100 mm (4 inch) diameter ball at all points.
d) **Swinging Hoistway Doors and Power Operated Horizontally Sliding Car Doors.** Where car door(s) are powered, and arranged so that the car door(s) cannot be closed until after the hoistway door is closed, and car door(s) automatically open when the car is at a landing and the hoistway door is opened, the measurement between the hoistway face of the hoistway door and the hoistway face of the car door at its leading edge shall not exceed 100 mm (4 inches). If it is possible for a user to detach or disconnect either door from the operator (such as in the event of operator failure) and such detachment or disconnection allows the user to operate the door manually, requirement 5.3.1.8.3(e) shall apply.
e) **Swinging or Horizontally Sliding Hoistway Doors and Manually Operated Horizontally Sliding Car Doors.** Where swinging or horizontally sliding hoistway doors and manual horizontally sliding car doors are used and both doors are in the fully closed position, the space between the swinging or horizontally sliding hoistway door and the manual horizontally sliding car doors shall reject a 100 mm (4 inch) diameter ball at all points.

Renumber remaining Sections in 5.3.1.8.

Rationale: Moved requirements for clearance between hoistway door and car door or gate. Reduced clearances based on Hazard Analysis and provided additional detail to define the clearance requirement for various door or gate combinations.