UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

2000 SEP -6 P 4: 37

VOTE SHEET

DATE: August 31, 2000

TO: The Commission
Sadye E. Dunn, Secretary

FROM: Michael S. Solender, General Counsel
Stephen Lemberg, Assistant General Counsel
Lowell F. Martin, Attorney, GCRA (ext. 2217)

SUBJECT: Escalator Petition (CP 97-1)

VOTE SHEET

The attached staff briefing package recommends that the Commission deny petition CP 97-1 related to escalators on the basis of a voluntary standard. The petition, dated April 9, 1997, filed by Scott and Diana Anderson, requests development of a mandatory safety standard for escalators. Specifically, the petition requests actions to: (1) close the gap between the moving stair and the sidewall; (2) notify the public about how dangerous escalators can be and what type of accidents can occur while riding one; and (3) create better warning signs that will educate and inform riders.

Please indicate your vote on the following options.

I. DENY THE PETITION. STAFF WILL PREPARE A DRAFT LETTER OF DENIAL FOR COMMISSION CONSIDERATION.

_____________________ (Signature) _____________ (Date)

II. GRANT THE PETITION. STAFF WILL PREPARE A DRAFT ADVANCE NOTICE OF PROPOSED RULEMAKING FOR COMMISSION CONSIDERATION.

_____________________ (Signature) _____________ (Date)

NOTE: This document has not been reviewed or accepted by the Commission.
Initial SD Date 8/31/00

CPSA 6 (b)(1) Cleared 8/31/00
No Mfrs/Prvtlbrs/or Products Identified
Excepted by

III. TAKE OTHER ACTION (please specify).

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______________________________ ______________
(Signature) (Date)

Attachment

000001

ESCALATOR PETITION

(CP 97-1)

August 2000

For Further Information, Contact:
Patricia L. Hackett
Directorate for Engineering Sciences
(301)504-0494 x1309

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EXECUTIVE SUMMARY

On April 9, 1997, Scott and Diana Anderson petitioned CPSC for the development of a mandatory safety standard for escalators with regard to the gap between the moving stair and the sidewall. The petition alleged that escalators are associated with unreasonable risks of serious injuries resulting from entrapment of feet, toes, and other body parts in openings between the moving stairs and stationary sidewalls (i.e., the "skirts") of escalators. Specifically, they requested actions that would 1) close the gap between the moving stair and the sidewall; 2) notify the public about how dangerous escalators can be and what type of accidents can occur while riding one; and 3) create better warning signs that will educate and inform riders.

In 1997, the escalator industry funded a research project to look at step/sidewall entrapments and to develop a performance standard for escalators to eliminate or reduce the number of incidents. The research was concluded in 1999 and resulted in the development of new voluntary code requirements for escalators. The staff believes that the changes to the escalator safety code, based on the results on the work sponsored by the industry, represent substantial improvements and will adequately reduce the risk of entrapment between the step and the skirt of the escalator. Therefore, staff recommends that the commission deny the petition.

In 1998, there were an estimated 7,000 escalator-related injuries treated in U.S. hospital emergency rooms, based on data from CPSC's National Electronic Injury Surveillance System (NEISS). Falls and miscellaneous incidents accounted for approximately 5,800 injuries. The remaining 1,200 of these injuries involved a body part, clothing, or shoes becoming entrapped in the escalator. Children appeared to be at greatest risk of entrapment injury. While step-to-skirt entrapment injuries have not been known to be fatal, these injuries can be severe in nature, some resulting in deformity and disability.

Currently, escalators are regulated at the state and local levels. The safety code adopted by many of these jurisdictions is published by the American Society of Mechanical Engineers (ASME) under the auspices of the American National Standards Institute (ANSI). This voluntary code, ASME A17, has three main parts: 1) A17.1 for new installations, 2) A17.2.3 for escalator inspectors' manual and 3) A17.3 for existing installations. The A17.1 code may also apply to some existing escalators that have been altered. For example, when an escalator is relocated, it is considered a new installation.

There are parts of the current code that pertain to sidewall entrapment. These include the requirement for the step/skirt gap and the lubrication requirements of the skirts. The step/skirt clearance requirement in ASME A17.1 during the years 1955 through 1970 was less than 3/16 in. (4.8 mm) with a total for both sides of less than 1/4 in. (6.4 mm). In 1971, the code changed and the new requirement was less conservative, allowing up to 3/8 in. (9.5 mm) on each side. In 1980, the code went back to 3/16 in. (4.8 mm) but had no limitations for both sides. The current code, Fifteenth Edition, ASME A17.1c-1999 has the same requirement. The code also addresses the friction of the skirt panels. Since 1982, A17.1 has required that skirt panels shall be made from a low friction material or treated with a friction-reducing material.

In 1996, CPSC staff met with representatives of the escalator industry to discuss the issue of safety and, more specifically, sidewall entrapment. The staff was concerned that there was no performance requirement nor a good method for evaluating sidewall entrapments. As a result of the meeting, an escalator trade organization, the National Elevator Industry, Inc. (NEII) contracted with Arthur D. Little (ADL) to look at the sidewall entrapment issue. This work consisted of running numerous tests on a variety of different escalators. For the first phase of tests, ADL used plastic objects that were modeled to be similar in size to child and adult fingers, children's calves and children's shoes. After this phase of work, ADL concluded that a variety of factors influence the probability of entrapment. These factors were coefficient of friction between the object and the skirt, gap size, and skirt/step stiffness. In order to determine how these factors related to each other and to help predict the probability of entrapment for a given escalator, ADL conducted an additional phase of testing.

In phase II, ADL used "real life" objects for testing purposes. These objects were manufactured by Pacific Research Laboratories, Inc. and were simulated body parts consisting of individual polymer bones, foam representing muscle and a separate foam layer representing skin. Children's calves, hands and sneaker-enclosed feet were used for this phase of testing. Using these objects, tests were conducted to determine how the different factors identified in phase I contributed to entrapments.

In phase III, ADL developed the concept for an instrument to measure these factors on a running escalator. Once measured, a value, called the Step/Skirt Performance Index (Index) can be calculated. The Index uses a formula based on several measurements including the gap between the step and the sidewall and the coefficient of friction of the sidewall. The Index can vary between 0.0 to 1.0. The lower the Index, the lower the probability for entrapment exists.

ADL's study was concluded in August 1999. In their final report, ADL recommended that the ASME escalator code be changed to include the Index as part of the performance standard. Based on the ADL work, NEII submitted a Technical Revision (TR) to the ASME A17 code committee proposing that the next addendum of the code as well as the next version of the code include the Index as a performance standard. This proposal was approved by the A17 main committee in January, 2000 and by ASME in August, 2000. The addendum code is expected to be published in October, 2000. The 2000 version is expected to be published before the end of the year.

To meet the new code requirements, new escalators must have an Index of 0.15 or below, while existing escalators must fall below 0.40. In addition to limiting the Index, the new addendum code requires that skirt-mounted deflecting devices be installed on existing escalators with Indices above 0.15 and below 0.40. As approved, the next edition of the code, ASME A17.1-2000, would lower the 0.40 Index maximum to 0.25. Skirt deflecting devices would still be required on escalators with Indices between 0.15 and 0.25. Skirt deflecting devices, such as brush deflectors, have been shown to influence where people stand on an escalator step and reduce the risk of a sidewall entrapment.

ADL's data suggests that a majority of escalators already in the field will have to be modified or repaired in some manner in order to meet the new requirements. This modification will likely include the addition of a deflector device on many existing escalators which will provide an additional safeguard that does not currently exist.

As a result of more than two years of study by ADL, the code has been revised to include the use of a performance Index. This Index takes into consideration several factors, most notably the coefficient of friction and the size of the gap under a 25-pound load. In addition, the sidewall stiffness requirement remains in the code. The Index will provide a means to evaluate escalators with a performance test, for the potential of entrapment. The new test method in the code will, for the first time, require that the escalator be tested along the entire incline portion of both sides while the escalator is moving.

After the new code is issued, local jurisdictions may adopt it. Since the code only becomes mandatory when and if it is adopted by the local authority having jurisdiction (AHJ's), this can be an obstacle with regard to getting the new code adopted throughout the U.S. In order to encourage quick adoption of the new A17 code, NEII has committed to a national escalator safety program that will target building owners, maintenance contractors, inspection authorities and escalator consultants. This program will stress the importance of the new code requirements in an effort to push adoption.

Before the industry undertook this work, the entrapment provisions in the standard were limited to a static measurement of the step/skirt gap, a stiffness requirement for the sidewall, and a qualitative statement about the coefficient of friction. The staff concludes that the new ASME A17.1 code requirements are a positive step and will adequately reduce the step/skirt entrapment hazard on escalators. In addition, five manufacturers, all who actively participate in the ASME A17 committees and NEII, have provided letters to CSPC staff that state their commitment to producing new escalators that meet or exceed the revisions to the code, regardless on whether or not it is adopted throughout the U.S. According to NEII, these five manufacturers make up over 99% of the market for new escalator sales in the United States. It is for these reasons, that the staff recommends that the Commission deny the petition.

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

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Memorandum

MEMORANDUM

DATE: AUG 3 1 2000

To:	The Commission Sadye E. Dunn, Secretary
Through:	Michael S. Solender, General Counsel M.S.S. Thomas W. Murr, Acting Executive Director TM
From:	Ronald L. Medford, Assistant Executive Director, RLM Office of Hazard Identification and Reduction Patricia Hackett, Project Manager PH Directorate for Engineering Sciences
SUBJECT:	Petition Requesting Development of a Consumer Product Safety Standard for Escalators (CP 97-1)

I. BACKGROUND

In a letter dated April 9, 1997, Scott and Diana Anderson petitioned the U.S. Consumer Product Safety Commission (CPSC) for the development of a mandatory safety standard for escalators (TAB A). On February 17, 1996, their 4-year-old son had toes amputated and other serious injuries to his foot when his shoe became entrapped between the sidewall (i.e., the "skirt") and steps of a moving escalator. The Andersons alleged that escalators are associated with unreasonable risks of serious injuries resulting from entrapment of feet, toes, and other body parts in openings between the moving stairs and the sides of escalators. Specifically, they requested actions that would:

a) close the gap between the moving stair and the sidewall;
b) notify the public about how dangerous escalators can be and what type of accidents can occur while riding one;
c) create better warning signs that will educate and inform riders.

The Andersons' request was docketed as a petition on May 5, 1997. CPSC solicited public comments on this petition in a Federal Register notice published on May 22, 1997.

NOTE: This document has not been reviewed or accepted by the Commission.
Initial SD **Date** 8/31/00

CPSA 6 (b)(1) Cleared 8/31/00
No Mfrs/PrvtLblrs or Products Identified
Excepted by
Firms Notified,

Previously, on April 18, 1978, the Commission received a petition and supporting documents from members of the Ad Hoc Committee for Greater Safety on Escalators of Cleveland, Ohio. The petition alleged that escalators present an unreasonable risk of injury, particularly to children and the elderly, due to inadequate warning signs and unsafe construction and design. The petition called particular attention to the risk of body parts being pulled into the escalator mechanism. The Commission denied the petition, indicating that the injury data were insufficient to show that escalators presented an unreasonable risk of injury, considering the frequent use of escalators by consumers. The Commission also considered the relative priority of the risk of injury associated with escalators in the context of Commission resources available for addressing other product hazards at that time.

II. DISCUSSION

A. Incident Data

1. Emergency Room-Treated Injuries

The CPSC's Directorate of Epidemiology (EP) estimates that from 1994 through 1998, there was an average of 5,800 escalator-related injuries treated annually in U.S. hospital emergency rooms, based on data from CPSC's National Electronic Injury Surveillance System (NEISS) (TAB B). Children younger than 15 and persons 65 and older were the victims of over 40 percent of the injuries. However, these age groups represent only about 20 percent of the U.S. population.

In 1998, there were an estimated 7,000 escalator-related injuries treated in U.S. hospital emergency rooms. Over one-third (36 percent) of the injuries were to the leg/foot area. This was followed by the arm/hand area, with about 28 percent of the injuries; the head/face area, with about 17 percent of the injuries; the lower trunk, with about 12 percent of the injuries; and other locations, with about 7 percent of the injuries. The relative frequency of injury to certain parts of the body may be of interest in evaluating the adequacy of test methods developed to address entrapment hazards. Specifically, these include injuries to the lower leg, including the calf (570 injuries, of which about 75 involved entrapment); hand/finger (890 injuries, of which about 590 involved entrapment); and foot/toe (460 injuries, of which about 270 involved entrapment). Please note, however, that these estimates are based on very small sample sizes and may be subject to a large degree of variation.

As shown in Table 1, almost three-fourths of these injuries (5,000) occurred as a result of falls on the escalator. About 1,200 were caused by a body part, clothing, or shoes becoming caught in escalators, although in most cases, data were not available in sufficient detail to determine what part of the escalator was involved. Typically these 1,200 incidents involved a side-wall/step entrapment or a combplate entrapment[1]. The sample sizes were not large enough to compare the severity of entrapment injuries to injuries associated with other hazard patterns. The remaining 900 injuries primarily involved other minor injuries from non-specified contact with the escalator.

[1] Combplates are found at the edge of the landing plates at the entrance and at the exit of every escalator and are designed to mesh with the moving steps.

The majority of incidents involved injuries of a relatively minor nature, such as lacerations, contusions, or abrasions. However, about 13% of the injuries involved diagnoses that could be judged as potentially serious, such as fractures, internal injuries, dislocations, concussions, avulsions, crushing, and hematomas. Over 97 percent of the victims were treated and released.

Children appeared at particular risk of entrapment injury. Among children younger than 15 years of age, approximately 50 percent of their estimated injuries involved the child's hands, legs, or feet becoming caught in the escalator. Among other ages, this pattern accounted for less than 10 percent of the injuries.

When reported, injuries frequently occurred in shopping malls or department stores. Injuries were also reported to have occurred in airports, hospitals, subway stations, ballparks and racetracks.

Table 1: Escalators - Estimated Number of Emergency Room-Treated Injuries by Age of Victim and Type of Hazard, 1998

	Hazard Pattern			
Age (in years)	Total	Falls	Body Part, Clothing, or Shoe Caught	Other
Total	7,000*	5,000	1,200	900
< 5	900	400	400	100
5 – 14	900	300	400	100
15 – 64	3,200	2,500	300	400
65 +	2,000	1,800	<100	200
* Cells may not add up to totals due to rounding.				

Source: National Electronic Injury Surveillance System (NEISS), 1998
U.S. Consumer Product Safety Commission/EPHA

2. *Deaths*

Since 1985, CPSC received reports of 27 deaths associated with escalators. The hazards associated with these deaths were falls (21), clothing entanglement in the escalator combplates (4), crushing (1), and electrocution (1). Of the 27 deaths, one victim was a 3-year old child, 11 victims were between the ages of 24 and 64, 14 were over 65 years of age, and one was described as an "adult." None of the deaths would have been addressed by safety provisions regarding the step-to-skirt gap called for in the petition.

3. *Other Data*

A review of newspaper clippings, consumer complaints, and other data received from 1990 through November 1999 revealed reports of 79 non-fatal escalator-related incidents that involved

99 victims, or about 10 incidents per year (fatal incidents were included in the count of deaths above). Of the 99 victims, 68 were involved in incidents associated with entrapment or entanglement of body parts or clothing. An additional 27 victims were reported to have fallen on the escalator, and in 4 cases the circumstances involved in the incident were not reported. While these injury reports were not a complete count of all escalator incidents or a statistically representative sample, they nevertheless provided useful information about the circumstances involved in some serious injuries.

B. Product and Market Information

Information provided by the Directorate for Economic Analysis (TAB C) describes the escalator market, identifies some safety devices available to prevent step/skirt entrapment, and provides estimates of the societal cost of entrapment injuries.

The American Society of Mechanical Engineers (ASME) defines an escalator as a power-driven, continuous inclined stairway used for raising or lowering passengers. The U.S. market for escalators is dominated by a few multi-national companies. The five largest manufacturers are Kone Elevators and Escalators, Schindler Elevator Corporation, Otis Elevator Company, Fugitec America and Thyssen Elevator. All of these major companies also provide maintenance services. Some also provide after-market safety device upgrades. In addition, there are firms that remove and recondition old escalators for installation in new locations; provide repair and modernization services for existing equipment; and supply replacement parts. Other firms provide step cleaning and polishing equipment, safety devices, signage, and audible safety message systems. The owner/operator of the escalator is responsible for its maintenance and continued compliance with the manufacturer's specifications and ASME requirements.

Escalators are often prefabricated and shipped to the installation site, where they are reassembled and installed. They are generally purchased for new construction or renovation of hotels, shopping malls, recreational facilities such as theaters and stadiums, multi-level retail stores, office buildings, and mass transit systems. Using the use category data provided by several escalator manufacturers in 1999, staff estimates that roughly 17 percent of all new escalator installations made in the U.S. during the period 1969-1999 are in service in or around long- or short-term residences or schools, or are used in recreation. Also, many of the "retail" locations comprising 40 percent of the uses reported by the manufacturers could fall within the "recreation" category because almost all shopping malls include recreational opportunities such as video arcades, movie theaters, and restaurants.

Sales of escalators since 1980, as reported in 1999 by the National Elevator Industry, Inc. (NEII), amount to about 18,500 units. NEII also estimates that there are about 30,000 escalators in use. This estimate, however, may be understated to some extent because some manufacturers were not members of NEII (the organization that compiles the statistics) for some of the years for which escalator sales data were reported.

The ages of the escalators in use are not known; according to an industry spokesperson, some properly maintained indoor escalators could last 30 or more years, and there are some that are over 50 years old. The life expectancy of an outdoor escalator, such as used in a transit system, is closer to about 15-20 years because of its continuous operation (20 or more hours per day) and the adverse weather conditions to which it is frequently exposed.

The cost of an escalator will vary according to its features, length, and brand. According to an article in The Walla Walla Union-Bulletin dated April 13, 1986, a new escalator could be purchased in 1986 for $150,000. The Washington Post (June 19, 1992) reported a proposed installation of three new escalators for a Washington D.C. metro station at an estimated cost of approximately 1 million dollars. These units were said to carry heavier loads, last longer, require less maintenance, and have step/skirt gaps that were smaller than existing units. According to the November 1997 issue of The Elevator World, a heavy-duty escalator (one-direction) purchased for the San Francisco's BART system in 1977 was reported to have cost $550,000, including a maintenance program, spare parts, and installation.

The total estimated societal costs for the estimated 7,000 non-fatal escalator injuries treated in U.S. hospital emergency rooms in 1998 were about $85.5 million, according to the CPSC Injury Cost Model. Entrapments accounted for an estimated $14.5 million of these costs. It appears that none of the reported deaths would be addressed by reducing the step-to-skirt gap.

C. Analysis of Public Comments

On May 22, 1997, CPSC published a Federal Register notice that solicited written comments from the public on the Petition. CPSC received 24 responses from a variety of sources, including trade/industry organizations (7), safety consultants (5), ASME A17 committees (3), escalator manufacturers (3), consumers (2), the United States Senate, the American Academy of Pediatrics, a law firm, and a building code organization. Of the 24 organizations and individuals that responded, 10 favored granting the petition or undertaking a full review of the problem by the CPSC, and 14 recommended denial. The main issues included in the public comments, as well as the staff responses, are summarized below:

Issue: CPSC jurisdiction over escalators

Eight respondents (including five trade/industry organizations and three manufacturers) suggested that from a legal perspective, escalators are not consumer products but, rather, industrial products or real estate fixtures that would not fall under CPSC jurisdiction. One safety consultant, however, indicated that escalators are consumer products within the jurisdiction of CPSC. In support of his position, he provided a 1978 letter from CPSC's General Counsel advising that escalators are consumer products.

Response:

This issue is addressed in a separate memorandum from CPSC's Office of the General Counsel.

Issue: State and local regulation of escalators

Eight respondents (including four trade/industry organizations, two manufacturers, an ASME A17 representative, and a building code official) noted that escalator installation and maintenance are already regulated by state and local governments through enforcement of

ASME A17, and that additional regulation by CPSC is not necessary. Two respondents (from ASME A17 and a trade organization) suggested that while local enforcement is appropriate, enforcement could be improved. A building code official mentioned that escalator requirements would be difficult for CPSC to enforce.

Response:

Currently, safety inspections are usually done by local jurisdictions in accordance with the A17 code, if required in that jurisdiction. However, even if a jurisdiction requires conformance through building codes or local legislation, escalators may not necessarily be required to conform to all sections or to the most recent version of the A17 code. Because there is no guarantee that such code changes will be adopted by all local jurisdictions, NEII has committed to a national escalator safety program that will target building owners, maintenance contractors, inspection authorities and escalator consultants. This campaign will commence before the new code is issued and will stress the importance of the new code requirements in an effort to push adoption at the local levels.

Issue: CPSC participation in the voluntary standards process

Thirteen respondents (including six trade/industry organizations, three ASME representatives, two manufacturers, a building code official, and a safety consultant) recommended that CPSC defer to and participate in the voluntary standards process by becoming an active member of A17. Some noted that the voluntary safety code for escalators is already in place and can adapt quickly to new concerns. It was suggested that mandatory standards may be slow in development and may not properly address all risks involved.

Response:

Since mid-1996, CPSC staff has participated in several committee meetings of the ASME A17 committee and is currently a corresponding member of the A17 Main Committee and other subcommittees. At the time the public comments were received, the revised code presented by NEII had not been submitted to ASME. The recommended improvements in the code to address sidewall entrapment have since been adopted by ASME and will be incorporated into the next edition of the code.

Issue: Maintenance

Six respondents (including two ASME A17 representatives, two trade/industry organizations, and two safety consultants) suggested that owner maintenance is a key factor in safety. It was noted that maintenance is not performed in a consistent manner and that poor maintenance may be a widespread problem. It was also suggested that enhanced training is needed for those who maintain and inspect escalators, and that improved maintenance may be difficult to legislate.

Response:

Staff agrees that proper maintenance is important for the safe use of escalators. The frequency and type of maintenance should be as recommended by the manufacturer, or, at a minimum, as specified by the A17 code. Because safety problems can occur when maintenance is not done properly, staff believes that manufacturers should provide specific information to its customers about the type and frequency of maintenance required to insure continued safe use of their product.

Issue: Technology to address hazard

Four respondents (including two safety consultants, one trade/industry organization, and one manufacturer) provided information to indicate that technology already exists to address entrapment hazards on new escalators and to retrofit existing units. Two other commenters, representatives of ASME A17, suggested that not enough data are available to conclude that after-market safety devices are as effective as their manufacturers claim, and that maintenance is an important factor in their safe use.

Response:

The staff believes that technology is currently available to enable compliance with new performance requirements to reduce the risk of entrapment. One method of conforming to such a requirement may be through the reduction of the size of the allowable step-to-skirt gap. Staff is aware of one add-on product that reduces the gap and is now being used in both new and retrofit applications by both jurisdictions and manufacturers. In at least two major metropolitan transit systems, the use of this product was reported to have eliminated step-to-skirt entrapment incidents. Other methods of conforming to new entrapment performance requirements may involve modification of other elements of escalator design, such as the stiffness of components, the speed of the escalator, and the durability of the guiderail system.

Issue: Injury data

Three respondents, two safety consultants and a law firm, provided information on escalator-related injuries from studies or compilations of data to illustrate the extent and nature of the problem, and support the need for mandatory requirements. However, the data did not quantify the extent of the national problem of entrapment in escalators. Three other respondents, including two trade/industry organizations and a manufacturer, suggested that escalators are one of the safest modes of transportation, considering their extensive use. A trade/industry group indicated that the available data do not show the causes of injuries, and that many incidents may involve misuse and unsafe behavior. A safety consultant disputed the petitioners' claim that there has been a 5,000 percent annual increase in injuries in recent years.

Response:

The staff is concerned that the risks of entrapment are highest for the very young. While most injuries are relatively minor, serious injuries do occur. For some injuries associated with entrapment, such as amputations, the long-term consequences to an individual can be devastating.

The CPSC staff has seen little evidence that misuse and improper behavior are involved in many escalator incidents. However, products that are used as extensively as escalators should be designed to be safe under diverse conditions of use and reasonably foreseeable misuse. For example, the staff believes that expected behaviors, such as a person standing too close to the sidewall, should not have serious injury consequences.

The petitioners' allegation that there has been a 5,000 percent increase in injuries since 1977 was incorrect. In deriving their estimate, the petitioners used NEISS data taken from a Federal Register notice[2] denying the 1978 escalator petition. In that notice, the CPSC staff reported that a search of NEISS identified 125 escalator injuries in a 15-month period. However, NEISS is a system for estimating the size of a problem on a national scale. The number of incidents used, 125, was the sample count for reports from NEISS hospitals, not the national estimate. The petitioners thus based their analysis on a comparison of this sample count to a recent national estimate. This is an incorrect comparison.

Issue: Need for improved warning signs and public information

Two respondents, including a safety consultant and the American Academy of Pediatrics, stated that warning signs need to be more visible. Toward that goal, the safety consultant indicated that the signs should be used on both sides of escalators, at the top and bottom landings, and on both new and existing units. The safety consultant also felt that the signal word, "Caution," on the sign currently required in the A17 code should be "Warning." Two respondents (a safety consultant and an A17 representative) indicated that the education program of the Elevator and Escalator Safety Foundation was important and should be expanded. Another safety consultant suggested that, as with cigarettes, warning signs and public notification do little good. A representative of a trade organization also believed that present warning signs are being ignored and that audible instructions may be necessary.

Response:

ESHF staff's evaluation of warning signs on escalators suggests that an appropriately designed sign could convey the proper message to some consumers. However, even a well-designed sign is unlikely to be as effective at decreasing the frequency of escalator step-to-skirt entrapment injuries as designing the hazard out of escalators or reducing access to the gap. Children under age 5, who appear more likely than adults to be involved in entrapment incidents, are unlikely to read warning signs. Thus, the effectiveness of any warning sign directed at the caregiver likely to be accompanying a young child would depend on the ability of the caregiver to control the behavior of the child.

Staff believes that the severity of step-to-skirt entrapments warrants the use of the signal word "WARNING," as opposed to "CAUTION." Also, the nature and consequences of the step-to-skirt entrapment hazard could be more specifically stated. The use of supplemental auditory warnings may be beneficial, but it is unknown how effective they would be in preventing sidewall entrapments.

D. Overview of Escalator Safety Codes and Standards

Information provided by the Directorate for Engineering Sciences (TAB D) describes the

[2] Federal Register, Volume 43, No. 199 – Friday, October 13, 1978

domestic and international standards that pertain to escalator safety. In addition, a discussion regarding an industry research study and how it changed the current code requirements is included.

1. Escalator Standards in the United States

Escalator safety requirements in the United States are contained in safety codes that are published by the American Society of Mechanical Engineers (ASME) under the auspices of the American National Standards Institute (ANSI). This is a voluntary standard that is maintained and updated by a working committee who meet on a regular basis. The escalator safety code, ANSI/ASME A17 "Safety Code for Escalators and Elevators," has three parts:

1. A17.1, for new installations and some existing escalators that have been altered;
2. A17.2, for inspectors, more specifically, A17.2.3, for escalator inspectors; and
3. A17.3, for existing installations.

The latest version of A17.1 was published in 1996. The next new version for A17.1 is dated 2000 and will be published at the end of this year. This version has an effective date of one year after publication. Each year between versions, an addendum is published if there are any changes approved by the A17 committee. For example, A17.1a-1997, A17.1b-1998 and A17.1c-1999 were published in 1997, 1998 and 1999 respectively. An addendum becomes effective 6 months after publication.

The latest version of A17.2.3 was published in 1998 and the latest version of A17.3 was published in 1996.

2. Model Building Codes in the U.S.

Prior to the year 2000, the United States had three model building codes:

1. Southern Building Code Congress International (SBCCI), which publishes the Standard Building Codes (SBC);
2. Building Officials and Code Administrators International (BOCA), which publishes the National Building Codes (NBC); and
3. International Conference of Building Officials (ICBO), which publishes the Uniform Building Codes (UBC).

Typically, state and/or local jurisdictions adopted one of the building codes, in whole or in part, through legislation. All of which require compliance with ASME A17.1. Very few jurisdictions in the U.S. do not have a building code. Escalators would generally not be found in such jurisdictions. When adopted at the state or local level, the building code become mandatory. Adoption of these codes is the most common method for how jurisdictions impose mandatory safety requirements for escalators. Enforcement of these mandatory requirements is also done at the state or local level.

In March 2000, a new International Building Code (IBC) was issued in order to harmonize the three U.S. building codes. The IBC was first drafted in 1997 by representatives of BOCA, ICBO and SBCCI. Their intent was to draft a comprehensive set of regulations for building systems consistent with and inclusive of the scope of the existing model codes. This code will serve as a replacement to the other three model codes. Section 3001.2, in Chapter 30 of the IBC states that all conveying systems shall conform to ASME A17.1.

After a new version of the A17.1 code is issued, local jurisdictions may adopt it, but are not required to. Since the code only becomes mandatory when and if it is adopted by the local authority having jurisdiction (AHJ's), this can be an obstacle with regard to getting the new code adopted throughout the U.S. Of all the jurisdictions that enforce an elevator/escalator code, only one jurisdiction does not use ASME A17.1, Pennsylvania, and it is in the process of adopting ASME A17.1. Recent legislation requires the Pennsylvania Department of Labor and Industry to adopt A17.1 in lieu of its current code by the end of 2001. This shows a high level of conformity to the A17.1 code across the U.S. The challenge will be to have the AHJ's adopt the new A17.1 code.

3. International Safety Codes

There are at least five International safety codes and standards for escalators:

1. Canada National Standard Safety Code for Elevators, Escalators, Moving Walks and Freight Platform Lifts,
2. European Standard Safety Rules for the Construction and Installation of Escalators and Passenger Conveyors,
3. International Standard's Escalators-Building Dimension Code,
4. Chinese National Standard's Testing Standard for Elevator, Escalator and Dumbwaiter, and
5. Japanese Industrial Standard's Inspection Standard of Elevator, Escalator and Dumbwaiter.

The Canadian, European and Japanese codes contain step-to-skirt gap requirements and Caution, Safety and/or Warning sign requirements; the requirements are similar to the A17.1 requirements. There are no step-to-skirt gap requirements or warning sign requirements in the International and Chinese codes.

4. A17.1 Step/Skirt Entrapment Code Requirements

The A17.1-1996 safety code contains several requirements that relate to step/skirt entrapment potential.

Rule 805.3f, Skirt Obstruction Device, is a requirement to shut down an escalator if sidewall entrapment occurs. These safety devices are generally in the form of switches, which are located behind the skirt and are activated when the skirt is displaced. This may occur as a result of kicking the skirt, or from its displacement. When an object, such as shoe or finger, becomes entrapped between the step and skirt, it causes the skirt to move away from the step. This then causes the skirt to contact the safety switch, which suddenly stops the escalator. In the current code, skirt obstruction devices are to be located so that the escalator will stop before the object reaches the combplate. This means a minimum of two safety switches are required on each escalator.

Directly related to the issue of safety switches is skirt panel deflection. Rule 802.3f (2) states, "Skirt panels shall not deflect more than 1/16 in. (1.6 mm) under a force 150 lbf (667 N)." If an escalator skirt panel easily deflects, there are some possible problems:

- entrapped objects can get pulled in deeper, causing more serious injuries, and
- there is a greater chance that the safety switches will be accidentally activated due to unintentional contact with a sidewall. Stopping a moving escalator can also cause injuries as a result of people losing their balance and falling.

Part (3) of this same rule pertains to the skirt's coefficient of friction, which can also effect entrapment potential. It reads as follows: 'The exposed surfaces of the skirt panels adjacent to the steps shall be smooth and made from a low friction material or treated with a friction reducing material".

Finally, the current A17.1 code dictates a maximum allowable gap between the step and the skirt; Rule 802.3e, Clearance Between Skirt and Step, states "The clearance on each side of the steps between the step tread and the adjacent skirt panel shall not be more than 3/16 in. (4.8mm)."

5. Historical A17.1 Code Regulations

The step/skirt clearance requirement in ASME A17.1 during the years 1955 through 1970 was less than 3/16 in. (4.8 mm) with a total for both sides of less than 1/4 in. (6.4 mm). In 1971, the code changed and the new requirement was less conservative, allowing up to 3/8 in. (9.5 mm) on each side. In 1980, the code went back to 3/16 in. (4.8 mm) but had no limitations for both sides. The current code, Fifteenth Edition, ASME A17.1c-1999 has the same requirement. Before 1982, there were no provisions in the code dealing with skirt coefficient of friction (COF). Since 1982, A17.1 has required that skirt panels shall be made from a low friction material or treated with a friction-reducing material. An exact requirement for COF has never been part of the code.

In 1999, a Technical Revision (TR) to the code was submitted to the ASME A17 Working Committee on Escalators for consideration. This TR was submitted by the National Elevator Industry, Inc. (NEII), an escalator industry trade organization which has several major manufacturers as members. The TR is a rewrite of the current code, with regard to step/skirt entrapment requirements. It is the result of a two-year study performed by Arthur D. Little (ADL), on behalf of NEII. ADL was contracted to study issues related to sidewall entrapment, and to determine how to reduce or prevent entrapment incidents. A basic overview of the ADL study and a review of the TR requirements follow.

D. Industry Research

On May 14, 1996, CPSC staff met with the A17 Main Committee to discuss the issue of escalator safety and, more specifically, sidewall entrapments. At that time, CPSC staff suggested that, rather than simply measuring the gap between the step and skirt, industry should develop a performance requirement to address the sidewall entrapment potential. This performance requirement could then be used to determine whether an existing escalator might pose a potential for entrapment.

As a result of this meeting, the National Elevator Industry, Inc. (NEII), the escalator industry trade organization, contracted with ADL to perform a scientific study of escalator step/skirt entrapment potential and to develop a step/skirt performance index (Index).

1) The ADL Study

The ADL study was conducted in three phases. The first phase was to develop an understanding of the step/skirt entrapment process and the parameters that contribute to this process. In this phase, ADL studied the interaction between humans and escalators that led to escalator entrapments. Several scenarios were developed. Two involved foot/shoe/toe entrapment where (1) the shoe is caught in the gap between the sidewall and the step or (2) the shoe is caught between the sidewall and the riser behind the step where the subject is standing. A third scenario involves calf entrapment when a child is sitting on a step and the calf is positioned against the skirt. The fourth scenario describes hand or finger entrapments. This occurs with a person sitting and then resting a hand on the side of the step near the gap. The scenario may also occur when a person falls on the escalator, then grasps the side of the step with his hands.

ADL's analysis considered the forces involved in entrapments from a theoretical perspective. The entrapment event begins with a body part placed against the skirt. A friction force then decelerates the body part or stops the body part from sliding along the skirt. The body part then either rotates or wedges into the gap between the step and the skirt or the riser and the step. The physics involved require the force exerted by the object to overcome the combined lateral stiffness of the step and skirt panel in order to become entrapped.

The theoretical analysis was tested on two laboratory escalators with simulated objects. These objects were made from plastic and were similar in size to child and adult fingers, children's calves and children's shoes. The testing consisted of placing the object, under a given load, at the gap location; then running the escalator for a prescribed distance. Following the run, an observation as to whether or not the object was entrapped was recorded. Operational parameters on the escalator were varied to determine their influence on the entrapment potential. This phase was completed in July 1998. TAB E contains a report summarizing that work. ADL's Phase I report concluded that several factors were observed to affect the likelihood of entrapment.

Phase II, the development of a step/skirt performance standard based on the potential for step/skirt entrapments, commenced following Phase I. In this phase of work, ADL performed additional testing, using replicas of actual body parts. These objects, all the size of a young child, represented a calf, a foot and a hand. These objects were manufactured by Pacific Research

Laboratories, Inc. and consisted of individual polymer bones, foam representing muscle and a separate foam layer representing skin. Similar tests were conducted using the same laboratory escalators that were previously used.

Phase III ran parallel with Phase II and was undertaken to identify and generate concepts for inspection equipment. Phases II and III were completed in August 1999 and a report of the results was supplied to CPSC in September 1999 (see TAB F). Following that work, ADL performed some additional verification testing at the request of CPSC staff. A report outlining the testing was provided to CPSC in January 2000 and is included as TAB G.

2) Results of the Study- The Step/Skirt Performance Index

The ADL study resulted in the development of a performance requirement to determine an escalator's Step/Skirt Performance Index (Index). The Index was developed to be a universal way to represent the likelihood of sidewall entrapment under simulated use conditions.

Indexes can range from 0.0 to 1.0. The lower the measured index of the escalator, the lower the risk for entrapment. The Index is based on the variables that ADL found to have the greatest influence on entrapment:

1) coefficient of friction (COF) between a moving object and the skirt,
2) step stiffness,
3) skirt stiffness, and
4) the measured gap between the step and the skirt

By having several variables, it allows manufacturers of new escalators, and owner/operators of existing escalators the flexibility of deciding what variable(s) they would modify to address the sidewall entrapment hazard. If an escalator sidewall skirt has a low COF it should allow an item placed up against the skirt to slide with the skirt, and not be pulled back into the gap as quickly, thereby reducing the initiation of the entrapment. If an escalator has a high step stiffness there should be little play in the steps from side to side. And if an escalator has a small gap it would be more difficult for an object to become wedged between the step and the skirt gap.

The Index is calculated based on various parameters measured on the escalator while moving at its rated speed. A test instrument, affixed to a step and operated from the top to the bottom along the incline of the running escalator, is used to measure these parameters. This instrumentation will be capable of measuring the running coefficient of friction (COF) of the skirt. At the same time, another part of this instrumentation would apply a 25-lb force against the skirt and record the gap between the step and the skirt. The purpose of the 25 pounds is to account for excessive wear of any components by keeping the step shifted to the opposite side of the track. By applying the 25 pounds, the stiffness of the step and skirt are taken into account and thus the gap measurement is now considered a "loaded" gap. This measurement is different from what is required in the current A17.1 Step/Skirt Gap Requirements. In the current A17 code, the gap refers to a static gap, which is measured while the escalator is at rest and under no load conditions. A static gap will always tend to measure smaller than a loaded gap for the same escalator at a given time.

3) Analysis of the Index Study

ADL's report relied on testing data generated over a period of time using several different escalators. Due to the number of variables that exist among escalators, ADL determined that there were 108 unique escalator combinations of variables that could be tested and 21 different object combinations. This results in 2,268 total unique conditions that could be tested. Thus, they decided that it was not practical or necessary to test all of these conditions and instead, used statistical experimental design principles to help focus their testing. ADL ended up running a total of 242 test runs; 158 were unique escalator/object configurations and 84 were repeated test configurations.

The ADL study appears to be the most thorough and comprehensive technical analysis performed to date with regard to the entrapment issue. Previous code requirements, such as gap sizes and stiffness requirements were determined by experience and practicality. COF requirements have been discussed for 20 years at ASME, but before the Index test procedure was developed, there was no consistent way to test an escalator's COF. Committee members knew it was an important issue, but could never agree on an acceptable value because of the testing problem. Therefore, they simply put in a requirement for lubricated skirt panels, without being specific as to the required COF. With the proposed Index requirements, COF can now be measured and will be indirectly specified in the code. Before the ADL study, scientific research was not undertaken when code changes were recommended. ES staff believes that the Index approach to step/skirt entrapments has great merit. It will reduce entrapments because it reduces the loaded gap.

The Division of Hazard Analysis in the Directorate for Epidemiology (EP) evaluated ADL's report from a statistical viewpoint (TAB H). The central item in the research and the proposed improvements to the escalator safety code is the Index. This Index combines coefficient of friction, initial gap, step and skirt stiffness, and object force into a single measure of the escalator's resistance to entrapments. This approach represents a new concept in this field.

ADL and NEII decided to conduct tests on a laboratory escalator in order to evaluate the relationship between an escalators physical parameters and possible entrapment because the epidemiological data available was insufficient to determine how these incidents typically occur. The simulated entrapment data developed in this research is the largest and most comprehensive database relating escalator parameters to the entrapment hazard. The study resulted in NEII submitting a Technical Revision (TR) to the ASME A17 subcommittee on Escalators to change the code requiring that escalators meet a specific Index level.

A few problems surfaced during the study that revealed cases where the Index does not satisfactorily predict entrapments. These mainly concerned "large" objects, i.e.; the adult sized simulated objects used in the initial testing as well as the child's calf object used later on. The adult objects are less of a concern because adult entrapment injuries are relatively uncommon. The potential for child calf entrapments is a concern.

In TAB H, HA states the following: "Calf entrapment occurred at almost every level of the Index". The issue of calf entrapments is of concern only on escalators without deflector devices installed. Figure 1 shows an example of a typical brush type safety deflector.

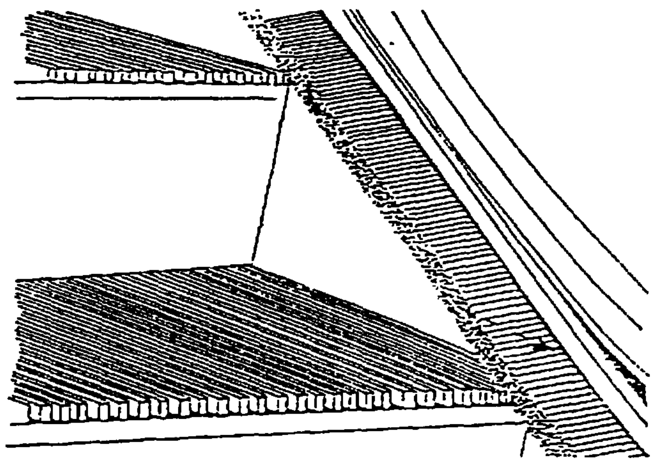

Figure 1: Typical Brush Type Skirt Deflector

A skirt deflector refers to a category of deflector designs that are typically attached to the skirt and run the complete length of the escalator. Their presence is supposed to help make riders stand toward the middle of the steps, as opposed to standing too close to the skirts. These deflector devices are especially useful in preventing calf entrapments because they serve as a physical barrier, preventing a calf from being pressed up against the sidewall. See TAB I for a Human Factors analysis and more information regarding the effectiveness of a skirt deflector.

Since the TR submitted by NEII only require escalators with Index values between 0.15-0.40 to have skirt deflectors, escalators with an Index less than 0.15 would not be required to have deflectors.

One way to address all calf entrapments by using brushes on every escalator, regardless of its Index value. But, despite the potential problem with calf injuries as seen across the Index levels in the ADL testing, it should be noted that based on the available NEISS data, calf entrapment injuries are rare. In 1998, they accounted for about 75 of the 7,000 injuries reported through NEISS[3]. Therefore, although calf entrapments may occur on escalators with Index values less than 0.15, the number of entrapments are low enough that deflectors may not be cost effective for these escalators.

The present escalator code does not require deflectors and is not specific about how to measure the gap. The staff believes that the ADL study and the resultant changes to the escalator code represents significant improvements. In order to meet this code, most existing escalators will

[3] TAB B, NEISS 1998 data, footnote 2.

likely require modifications, including the addition of deflectors. For the first time in the code there will be a dynamic performance standard requiring the loaded gap and COF to be measured along the escalator, on both sides. This is expected to reduce the potential for sidewall/step related entrapment injuries.

E. Warning Signs

CPSC's Division of Human Factors (ESHF) evaluated whether appropriately designed warning signs that will "educate and inform riders" can address the step-to-skirt entrapment hazard on escalators (TAB J). ESHF staff indicated that, to be most effective, warnings must change the behavior of those most likely to be involved in the hazard; and the change must be an appropriate one. A consumer must notice, understand, and believe a warning before there is any likelihood that he or she will follow it.

Young children appear more likely than other age groups to be involved in entrapment incidents, and are unlikely to read warning signs. However, since adults are likely to be riding escalators with children of this age, it would be more effective to direct any warning sign at the caregiver. This means that the effectiveness of any warning sign would depend on the caregiver's ability to control the behavior of the child. Thus, although an appropriately designed warning sign could convey the proper message to some consumers, it is unlikely to be as effective at decreasing the frequency of escalator step-to-skirt entrapment injuries as designing the hazard out of escalators or reducing consumer access to the step-to-skirt gap.

In response to comments on the petition regarding the current ASME A17.1 warning sign, ESHF staff concluded that the severity of injury as a result of side entrapments warrants changing the use of the signal word "WARNING," as opposed to "CAUTION." Also, the nature and consequences of the step-to-skirt entrapment hazard should be more specifically stated. While the alternate warning sign proposed by commenters has some advantages over the current sign, it also has similar failings. The use of supplemental auditory warnings can be beneficial, but it is unknown how effective they would be in preventing step-to-skirt entrapments.

F. New Code Changes with Regard to Step/Skirt Entrapments

The TR's submitted by NEII were approved by the A17 main committee in January 2000 and by ASME in early August 2000. They will be incorporated into both the A17.1d-2000 addendum as well as the A17.1-2000 new version of the code. The addendum is expected to be published in October of 2000 and has an effective date of 60 days after publication. The new 2000 version of the code is expected to be published before the end of the year, and will be effective one year after publication. The new code uses the Index as a performance requirement. The installation date of a given escalator determines how the code is applied to that escalator:

(1) *For new escalators installed before the A17.1d-2000 addendum, and for existing escalators the following would apply:* Escalators with a measured index of more than 0.4 would not be in compliance. Escalators with a measured index more than 0.15 but less than or equal to 0.4 would be in compliance only if they have skirt deflectors installed. In addition, they

would be allowed to use skirt lubrication to help keep them in compliance. Escalators with a measured index of 0.15 are in compliance.

(2) *For new escalators installed under the A17.1d-2000 addendum, the following would apply:* Escalators with a measured index of more than 0.4 would not be in compliance. Escalators with a measured index more than 0.15 but less than or equal to 0.4 would be in compliance only if they have skirt deflectors installed. Escalators with a measured index of 0.15 are in compliance.

(3) *For new escalators installed after the A17.1-2000 code becomes effective, the following would apply:* Escalators with a measured index of more than 0.25 would not be in compliance. Escalators with a measured index more than 0.15 but less than or equal to 0.25 would be in compliance only if they have skirt deflectors installed. Escalators with a measured index of 0.15 are in compliance.

After the new code is published, local jurisdictions may adopt it, but are not required to. Since the code only becomes mandatory when and if it is adopted by the local authority having jurisdiction (AHJ's), this can be an obstacle with regard to getting the new code adopted throughout the U.S. In order to encourage quick adoption of the new A17 code, NEII has committed to a year-long national escalator safety program that will target building owners, maintenance contractors, inspection authorities and escalator consultants. This program will stress the importance of the new code requirements in an effort to encourage adoption.

The staff believes that the changes to the ASME A17 escalator safety code, based on the results on the work sponsored by NEII, represent substantial improvements and will adequately reduce the risk of entrapment between the step and the skirt of the escalator.

G. Manufacturer's Commitment

ES staff requested input from the major U.S. escalator manufacturers with regard to their new production and how it relates to the results of the ADL study. Several manufacturers, Kone Elevators and Escalators, Schindler Elevator Corporation, Otis Elevator Company, Fugitec America and Thyssen Elevator, all who actively participate in the ASME A17 and NEII, provided letters to ES staff in January and February, 2000 that discuss their commitment to producing new escalators that meet the proposed revisions to the code (TAB E). These five manufacturers currently represent 99% of the U.S. market for new escalator sales. All five manufacturers stated that all new production lines will meet or exceed the new code requirements, regardless of whether or not the code gets adopted throughout the U.S. Some of the manufactures added that their current production line already meets the new requirements.

Tab H includes supplemental test results conducted by ADL in late 1999 at two escalator assembly plants on new, standard escalators. The loaded gaps for these new escalators measured 0.091 inch-0.10 inch, or slightly less than 1/8". Thus the static gap would be even smaller. This information indicates that escalator manufacturers are producing new escalators that have gaps that are significantly less than the current voluntary code requirement.

One major escalator manufacturer currently advertises that their new escalators are safer because they can maintain a 1/16 inch static gap. This is achieved by spring loaded guides located under each step which keep the moving steps centered. A 1/16 inch gap is one-third the current voluntary code requirement of 3/16 inch. A smaller gap should reduce the entrapment probability that small shoes or body parts will be caught between the step and skirt. ES Staff has also examined examples of newly installed escalators which have a dramatically reduced step-to-skirt gap. Therefore, it would appear that the industry has already taken the lead in reducing the risk of sidewall entrapments well before the introduction of this proposed Index.

I. Public Information

One organization established to alert the public to escalator hazards, the Elevator Escalator Safety Foundation (EESF), was created and funded in 1991 by four major associations within the industry. They were the National Association of Elevator Contractors (NAEC), representing local contractors and suppliers to the industry; the National Association of Elevator Safety Authorities (NAESA), representing inspectors within the industry; the National Elevator Industry, Inc. (NEII), representing major manufacturers and installers of equipment; and ELEVATOR WORLD, the international publication for the industry. The National Association of Vertical Transportation Professionals (NAVTP) later became a contributor and sponsor.

The Safe-T-Rider program, developed by the EESF, is targeted at second grade children. A second video training program, A Safe Ride, is targeted at the elderly.

In addition, NEII has committed to a national escalator safety program that will target building owners, maintenance contractors, inspection authorities and escalator consultants. This program will stress the importance of the new code requirements in an effort to push adoption. CPSC staff believes, however, that improving the safety of the products themselves is of foremost importance, and that educational efforts should only supplement the development of adequate performance requirements, where feasible.

III. OPTIONS

Options for Commission action to address escalator entrapment hazards are described below:

1. If the Commission finds that escalators may present an unreasonable risk of injury from sidewall entrapments, and that the recent revision to the ASME A17 escalator safety code are inadequate to address that risk, then the Commission may grant the petition and issue an advance notice of proposed rulemaking (ANPR) under the authority of the Consumer Product Safety Act (CPSA).

2. If the Commission believes that escalators may present an unreasonable risk of injury for sidewall entrapment but that additional information is needed before making a decision,

the Commission may direct the staff to obtain additional information before deciding on whether to grant or deny the petition.

3. If the Commission believes that escalators do not pose an unreasonable risk of injury from sidewall entrapment, or that the new ASME A17 escalator safety code is adequate to address that risk, then the Commission may deny the petition.

IV. CONCLUSIONS AND RECOMMENDATIONS

The staff recommends that the Commission deny the petition based on the following:

1. The latest version of voluntary escalator safety code ASME A17, that incorporates the performance Index discussed in this briefing package, is in existence, having been finally approved by ASME in early August 2000.

2. Due to inclusion of the Step/Skirt Performance Index criterion, the staff expects that the new code requirements will adequately reduce the risk of entrapment injury identified in the petition. To meet the Index criterion, manufacturers will reduce the gap between the steps and skirts of escalators and/or reduce the coefficient of friction of the skirts. Also, many existing escalators will be retrofitted with skirt deflectors to further reduce the risk of injury from entrapment.

3. CPSC has received letters of commitment from the major escalator manufacturers responsible for 99% of the U.S. market that all new escalators sold by them in the U.S. will comply with the revised ASME code. These commitments, coupled with the fact that the ASME code will be gradually incorporated into mandatory building codes throughout the country, are likely to assure substantial compliance with the ASME standard.

TAB A

SCOTT AND DIANA ANDERSON
6146 Piping Rock
Houston, Texas 77057

CP97-1

April 9, 1997

U. S. Consumer Products Safety Commission
Office of the Secretary
4330 East West Highway
Bethesda, MD 20814-4408

PETITION

After petitioning the assistance of God our Father, we, the undersigned, formally petition the Consumer Products Safety Commission as outlined in Section 10 of the Consumer Products Safety Act, to commence a proceeding, together with an investigation which will lead to the issuance of a Consumer Product Safety Rule to insure greater safety for persons of all ages on escalators, particularly our children.

There is an injustice that has been taking place in communities around the country for too long. That injustice is the inherent danger of escalators and how they are harming our children.

On Saturday, February 17, 1996, our little four-year-old boy, Scooter, was injured in an escalator accident. He and his father had gone to his office to pick up some information. As they were leaving, they got on the down escalator to exit through the tunnel to the parking garage. Scooter was on the same escalator step as his daddy and was holding on to the rail when his foot became entrapped between the sidewall and the step. Fortunately his daddy was able to pull his foot out of his tennis shoe. We have since learned that it is a very common injury to children. As they ride down the escalator, their tennis shoes rub against the metal sidewall causing the rubber to soften and slip into the gap. In Scooter's case, the impact of the machine pulverized half of the big toe and he lost his second and third toes instantly. The bottom of his foot was completely sliced back. After the second surgery, the big toe was amputated and skin was taken from his hip and used for grafting. His foot was sewn back together with over one hundred stitches. After seven surgeries, we are thankful he has a foot. After months in a wheelchair, walker and several walking casts, we are thankful he can walk. As the parents of a child who has been injured, we are committed to educating the general public of the inherent dangers of escalators.

The first week our son was in the hospital we were furnished with a news article outlining how often entrapment accidents occur to children (Exhibit "A"). We later requested the Consumer Products Safety Commission's most recent injury statistics (Exhibit "B"). We were appalled to learn that 1200 children under the age of 5 years were the victims of escalator accidents and approximately 500 of those children suffered side entrapment injuries. These numbers are the annual average for 1990-1994. Through further investigation, we found the CPSC was petitioned to review escalator safety in 1978 (Exhibit "C"). In the CPSC's denial of that petition (Exhibit "D"), it claimed that 125 accidents associated with escalators had been reported between January 1, 1977, and May 31, 1978. At that time there were approximately 18,000 escalators operating in the United States. Currently there are approximately 30,000 escalators operating nationally, and the CPSC reports 5900 accidents annually. That is almost 30,000 accidents over a five-year period, and a 5000% increase in injuries over the 1977 injury report. These numbers alone should be cause enough for the Commission to develop mandatory safety standards for escalators, but there is more injustice in these numbers. Of the 5900 accidents annually, over a third of the victims are children under the age of 15. These children make up over a third of the victims, yet they represent less than 10% of the riders on escalators. These statistics are outrageous and show that escalators, as they are presently designed and/or governed by safety codes, do present an unreasonable risk of injury to children. The escalator industry has shown itself to be a poor watchdog as indicated by these sky-rocketing number of annual injuries. The CPSC must adopt mandatory safety standards instead of allowing the escalator industry to set their own voluntary standards.

As stated in the Boston Globe article (Exhibit "E") dated Sunday, July 21, 1996: Page 3A, "the Consumer Products Safety Commission reversed its long-standing position and has determined that escalators pose a special threat to children. The USCPC concluded that escalators can be made less hazardous to children with the addition of safety devices that have been on the market, but were never before required." The article claims that the Consumer Products Safety Commission wrote in a July, 1996, letter to the chairman of the committee that sets the national escalator safety code, that "ALL of the information suggests that regular occurrences of entrapment, particularly of the legs and feet of small children, can be almost completely eliminated by the installation of after-market safety devices."

In conclusion, we agree completely with the CPSC's position stated in the Boston Globe on their concerns with escalator safety. We hope that our petitioning the CPSC will push the agency forward and cause real changes to take place with regard to:

a) design--more specifically closing the gap between the moving stair and the sidewall;

b) notifying the public how dangerous escalators can be and what type of accidents can occur while riding one;

c) creating better warning signs that will educate and inform riders.

We are a well-educated couple forced to learn of escalator entrapment injuries from stark reality. Please grant this petition so that other parents will not get educated the same way we were.

Respectfully submitted,

Diana Anderson

Diana Anderson

Scott Anderson

Scott Anderson

DA/SA/cc
Enclosures

EXHIBIT "A"

nost often harmed in escalator accidents

Ted Mase / Detroit Free Press

ole Caincross of Canton Township, Mich., lost ig toe in 1992 when the lace of her high-top sneaker caught in a department store escalator. She's had to give up gymnastics and dance.

all the accidents that have red and given the number of ties over the years," said Fox, etired from the state in Janu- do consulting work. Fox con- s to be a member of the Amer- Society of Mechanical neers' code committee that he national standards for esca- design and safety.

example, escalators can come abrupt stop for no apparent n, sending riders tumbling. times it's the result of a mal- oning safety trigger; some- someone has hit a safety stop . At other times, the cause ns a mystery.

said public education is the escalator safety.

cation is good, but it doesn't r enough, said Carl White, lent of a prominent escalator ting firm and an outspoken er of the industry's national ates, is in Colorado Springs, Colo.

In pushing to create a perception that riders cause accidents, White contends the industry is trying to avoid the costs of fixing safety hazards on escalators. Manufacturers and suppliers dominate the code committee that sets safety standards, White said. "The politics and the control of the manufacturers is unreal."

Russell Kramer, an escalator-elevator consultant who has testified in more than 575 court cases nationally, often for plaintiffs, agrees that rider safety and maintenance are important. But the machines still will be dangerous, said Kramer, whose firm recently moved from Detroit to Las Vegas.

"An escalator is inherently dangerous from day one," Kramer said. "You have a moving object next to a stationary object, so you have pinch points. Children's fingers, toes, feet devices to correct this. But the industry won't do anything about it."

The most important change needed on escalators is closing up the gaps in the machinery that catch people's fingers and toes, Kramer and White agreed.

For example, foot entrapment is the second-most-common cause of escalator accidents, after falls, according to White and an Otis Elevator ad. The main problem area for these accidents is the clearance gap between the sides of each moving stair and the stationary escalator wall.

A space is needed to keep the stairs from gouging into the wall. For safety reasons, the national escalator code mandates that the gap can be no more than three-sixteenths of an inch on each side. But as the escalator runs, the stairs can shift and cause larger gaps.

In 1983, White patented an inven- limit the chances of injury. He said escalator manufacturers weren't interested in making them a part of their standard equipment.

Today, about 600 escalators nationwide have been retrofitted with White's side plates, mostly at public buildings and transit authorities. It costs about $5,000 per escalator.

Since installing the side plates in 1985, the Metropolitan Atlanta Rapid Transit Authority has not had any entrapment injuries on its 140 escalators, MARTA officials said. Prior to installing the side plates, the escalators had caught about 75 shoes.

They didn't help Weston Goldsmith, unfortunately. His left hand was irreparably crushed in the side gap of an escalator at a Sears store in 1989. He was 3 at the time. And although he was holding his mother's pant leg, he put his left hand on the escalator stair to steady himself from falling. Sears spokeswoman Paula Davis said company policy prohibits discussing specific cases.

Philip Morosco, general manager of the center where the accident occurred, said he relies heavily on a contractor to maintain eight escalators in the mall's common areas and make sure they are in compliance. Additional escalators are controlled by stores at the mall.

Industry consultants like White say there are plenty of changes that could be made to escalators to make them safer:

- Painting colored lines on stairs can make it easier for people to judge their movement.
- More signs can warn of the dangers.
- Improved sensors within the side walls could stop the machinery more quickly and reduce injuries.

But there are no safety mechanisms for the escalator comb plates that could have spared Nichole and Donavan their amputations, White said.

White is especially critical of the Consumer Product Safety Commission for not making escalator manufacturers report injuries and for

EXHIBIT "B"

Table 3
Injuries Associated with Escalators by Age of Victim and Type of Hazard
Annual Average Estimates for 1990 - 1994

Age	Type of Hazard			
	Total	Falls	Body Part or Shoe Caught	Other
Total	[redacted]	[redacted]	[redacted]	[redacted]
Under 5 Years	[redacted]	700	500	*
5 - 14 Years	[redacted]	400	300	100
15 - 64 Years	[redacted]	1,700	200	300
Over 65 Years	[redacted]	1,600	*	*

Source: U.S Consumer Product Safety Commission / EHHA. National Electronic Injury Surveillance System.
* Estimate is less than 100. Estimates are rounded to the nearest hundred

 END

AD HOC COMMITTEE FOR GREATER SAFETY ON ESCALATORS

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EXHIBIT 000033

February 22, 1978

Office of the Secretary
U. S. Consumer Product Safety Commission
Logan Bldg. (L)
1118 18th Street Q N.W.
Washington, D.C. 20207

Dear Sirs:

After petitioning the assistance of God our Father, we, the undersigned, formally petition the Consumer Product Safety Commission, as outlined in Section 10 of the Consumer Product Safety Act, to commence a proceeding, together with such investigation as you find necessary, which will lead to the issuance of a Consumer Product Safety Rule to insure greater safety for persons of all ages on escalators, particularly children and the elderly.

After a member of our family was injured on an escalator (a four year old boy whose right foot was crushed) here in the Cleveland area in October, 1976, we felt obligated to look into the matter, hoping to alert the particular escalator manufacturer (Montgomery Elevator Co.-Moline, Ill.) that such a terrible accident had occurred on their product, and certainly hoping that such an alert would lead to an investigation and follow-up modification of any engineering defects. This all seemed eminently reasonable in view of the fact that this child's foot was pulled into the mechanism as he quietly was standing beside his mother, on the escalator, holding her hand, his other hand resting on the handrail.

Not only did our effort to gain any worthwhile results fail, but we had to experience an attempt on the part of the particular escalator manufac to counter any possible lawsuit on the part of the child's parents, by sendi an agent from the Commercial Union Assurance Company to get information from the mother, under the guise of an engineering investigator from the company, whose supposed interest was solely in protecting other youngsters from a similar accident.

Within two months of this accident, we were sent the enclosed clipping from a Pittsburgh newspaper, regarding two children injured on an escalator in Gimbel's Department Store in Pittsburgh. Both accidents occurred in December, 1976.

The shock of these three accidents led us to contact the Cleveland Consumer Action Foundation which referred us directly to Mr. John Gilmore of the Cleveland field office of the Consumer Product Safety Commission. At the same time, we contacted Mr. O. Earl Lowe, Executive Vice-President of the Greater Cleveland Safety Council, who encouraged our interest and furthermore provided us with the enclosed photostated information obtained from various branches of the National Safety Council. Mr. Lowe informed us that escalator injuries were very much a concern to the Safety Council. He spoke of one case in Chicago where a young boy was so seriously injured that brain damage resulted, from which the child will never recover. Until we received the photostated information from Mr. Lowe, especially the Inter-Office correspondence of the Otis Elevator Company, we had no idea accidents on escalators were this prevalent, numbering in the hundreds and even thousand

Mr. Gilmore, of the Cleveland branch of your Commission, courteously informed us that, as a result of our written complaint to him, we might proceed to make a formal petition to you in Washington, and he added to our accumulated evidence the enclosed statistics which your Washington office has currently on file, statistics drawn from NEISS Hospital reports.

Gentlemen, these statistics are frightening, and they graphically show that escalators, at least as they are presently designed and/or governed by any safety codes, do present an unreasonable risk of injury:

a) to children, the elderly and the handicapped particularly,
b) because of the frequency of accidents upon them, and the degree of severity of these accidents, ranging from mild injury to lifelong disability and in some cases, death,
c) due to lack of clear and adequate warnings or instructions by the manufacturers, even though they are aware of the potential dangers of their product,
d) due to the withholding from the general public, in most cases, knowledge of the accidents, and frequency,
e) due to the number of possible-injury sites in both design and construction, and/or possible lack of safety mechanisms.

The statistics we have been able to gather, which are only a fraction of a total which is overwhelming, point to a very urgent need that a C.P.S. Rule be issued to insure greater safety in the future. We are aware that the American National Standards Institute has published a Standard Safety Code for Elevators, Escalators, Dumbwaiters and Moving Walks (ANSI A 17.1-1971). It was prepared by the American Society of Mechanical Engineers Committee on Protection of Industrial Workers. Copies of this Code are available at a cost. However, we submit that the Code is insufficient, however comprehensive it might attempt to be.

In the enclosed photostated material, please note in the first article (WHAT YOU SHOULD KNOW ABOUT ESCALATORS taken from the Summer, 1972 issue of FAMILY SAFETY) that the instance of children's feet being pulled into the escalator mechanism is clearly explained:

"Feet and toes get caught because they are drawn into the pinch points. George Matwes, the safety director of Bamberger's department store in Newark, NJ, explains it this way: 'Children get caught by their footwear-sneakers, boots, galoshes-shoes with soft rubber soles. When a shoe or boot sole is run along the skirt (bottom edge of the side panel) of the escalator, the rubbing of the plastic-type soles creates friction which in turn heats the sole so that it stretches and gets into the mechanism.

"The shoe or boot then draws the foot into the crack and it may not be possible to pull free.' The safety director of another large department store says the escalator probably would pull the rider up or down to the limit of the switches located below the skirt guard on both sides of the steps. These switches automatically shut off the power when they're intercepted by a hand or foot that's caught between the escalator stair and the skirt guard on the side.

"Some escalators use only two switches on each side of the stairway, about 4 feet and 1-1/2 feet from the comb plate. Others have as many as six to 11 switches at intervals along the skirt guard."

The article then goes on to say that advisory signs and admonitions are prominently displayed, seeming to refer to this and other escalator hazards. Gentlemen, that simply is not true of all places where escalators are install[ed]. Perhaps it is common in other cities; it certainly is not done in Cleveland. We do not think it an exaggeration to say that most parents are totally unawa[re] that any such danger exists for their children.

In any event, escalator manufacturers (and anyone who may know that the periodical FAMILY SAFETY exists, and had carried an article in the Summer of 1972 about escalator dangers) are clearly aware that these possible-injury conditions exist, and have had this knowledge since said Summer of 1972 at least. We submit that the simple warning at the entrance of every escalator "Please Hold Handrail" does not convey the all-important "clear and adequate warning or instructions" to parents and all riders of escalators. It was only after yet another Cleveland child was injured in the Spring of 1977 that a department store in this area displayed a sign warning riders of the dangers of getting rubber soles caught in the mechanism. This was at Halle Bros. Co. in the Westgate Shopping Center. It is commendable that the department store itself displayed such a warning, but we submit that the real responsibility in this matter rests with the escalator manufacturers.

We have concentrated attention on only one area of unreasonable risk to children on escalators. There are others which your investigation will undoubtedly bring to light, and still more, with regard to safety to the elderly. Indeed the NEISS Hospital reports of injuries showed that all age groups are affected. One case was that of resultant death for a 43-year old male who suffered crushing injuries from an escalator mechanism.

Therefore, we ask that your Commission initiate an investigation which will hopefully lead to a sorely needed Safety Rule for all escalators. The entire scope of such a Rule has yet to be determined by the investigators and your Commission. Lacking engineering and technological expertise we can only call your attention to the number and frequency, as also severity, of accidents. We sincerely request that positive action be taken. We would hope that such a Rule would provide that

a) the entire nation be made aware that these accidents are occurring, and why.
b) That clear and adequate written warnings be displayed at entrances to all escalators.
c) That the entire matter of safety mechanisms and emergency shut-offs be examined by impartial engineers not connected with the Elevator-Escalator industry, and needed modifications made.
d) That all employees of stores using escalators be obliged to learn how to shut off an escalator should an accident occur. (When our small relative was injured, nearby employees did not know how to stop the moving stairs.)
e) That engineers be encouraged to develop "injury-proof" escalators by means of sensor systems or changes in construction or design preventing contact of shoes with the skirt guard. If our modern technology has taken men to the moon and brought them back safely, surely this is not an idealistic, unattainable feat.
f) That legislation be adopted requiring some form of marking be applied directly on the surface of all escalators delineating areas beyond which persons are prohibited to step.

We appreciate any consideration your Commission may give to this petition as small a voice as it may be challenging the giant of corporate industry. In helping us your Commission will be helping itself, yourselves and your children. To quote the three Medical Doctors in (the last photostated article included) HAZARDS TO HEALTH from the December 17, 1964 issue of the NEW ENGLAND MEDICAL JOURNAL:

"Injuries in the pediatric age group are a substantial percentage of the total escalator injuries and are thus a proper concern of the medical profession and public-health agencies. Four cases of serious escalator injury are reported.

"No substantial reduction in the frequency or severity of these accidents to children can be expected until there is a concerted effort to eliminate the conditions known to cause these accidents."

Our gratitude and kind regards,

AD HOC COMMITTEE FOR GREATER SAFETY ON ESCALATORS

Sister Mary Therese Zammikiel, P.C.C.

Thomas J. Zammikiel

Thomas C. Simiele

[6355-01-M]

CONSUMER PRODUCT SAFETY COMMISSION

[Petition No. CP 78-12]

ESCALATORS

Denial of Petition

AGENCY: Consumer Product Safety Commission.

ACTION: Denial of Petition.

SUMMARY: The Commission denies a petition requesting it to develop a mandatory safety standard addressing risks of injury associated with escalators. The Commission denies the petition because the currently available information is insufficient to indicate that escalators as they are presently constructed and designed present an unreasonable risk of injury to consumers.

FOR FURTHER INFORMATION CONTACT:

Irwin L. Greif, Office of Program Management, Consumer Product Safety Commission, Washington, D.C. 20207, 301-492-6754.

SUPPLEMENTARY INFORMATION: Section 10 of the Consumer Product Safety Act (CPSA) (15 U.S.C. 2059) provides that any interested person may petition the Consumer Product Safety Commission to commence a proceeding for issuance of a consumer product safety rule. Section 10 also provides that if the Commission denies such a petition, it shall publish its reason for denial in the FEDERAL REGISTER.

On April 18, 1978, the Commission received a petition and supporting documents from members of the Ad Hoc Committee for Greater Safety on Escalators of Cleveland, Ohio. The petition alleged that escalators present an unreasonable risk of injury, particularly to children and the elderly, due to inadequate warning signs and unsafe construction and design. The petition called particular attention to the risk of body parts being pulled into the escalator mechanism.

In analyzing this petition, the Commission considered injury information submitted by the petitioners, its own investigation of injury data, economic and engineering data, and applicable voluntary standards.

Two major hazards patterns emerged from a search of the Commission's National Injury Information Clearinghouse data: Falls, and entrapment of body parts or shoes between moving components of the escalator. Falls appear to be the most common type of accident associated with escalators and usually involve the elderly. Entrapment of shoes, feet, hands, and so forth is the second most common type of accident associated with escalators. This hazard seems to involve primarily children under 12.

The causes of entrapment accidents are generally quite specific—the victim is typically wearing soft soled shoe which becomes caught in the mechanism, or a child is playing on the escalator in such a way as to expose fingers or clothing to moving parts of the escalator. Most reports of falling incidents give only general statements as to cause, such as "lost balance," with no identifiable reason for losing balance.

A search of the National Electronics Injury Surveillance System (NEISS) revealed 125 accidents associated with escalators during the period January 1, 1977 through May 31, 1978. The age range of the victims was from five to 65+, with injuries ranging from contusions, to strains and sprains, to lacerations and fractures, with virtually all body parts being affected. A review of 21 in-depth investigation reports dating from 1967-77 disclosed 13 entrapment incidents and eight falls. In addition, 6 deaths involving escalators have been reported to the Commission. It appears that 2 of the 6 deaths may be classified as industrial in nature due to the type of injuries involved. The other 4 victims were injured when they fell down escalators.

Commission investigation reveals that these accidents are occurring in the context of at least 32 billion escalator rides per year, on 18,000 escalator units (a unit is either an up or down escalator).

The Commission notes that many States have statewide elevator and escalator codes. The American National Standards Institute (ANSI) Code for Elevators, Dumbwaiters, Escalators, and Moving Walks (ANSI A17.1), which has been adopted at least as a technical basis for a State code in 22 States, contains many safety features relating to fall, entrapment, and pinching hazards. In addition, Commission staff have been informed that the ANSI Escalator Subcommittee has recently approved and transmitted to the Executive Subcommittee a proposed revision of the escalator standard which would provide for the uniform placement of emergency on-off stop switches and would establish requirements for the size, wording, and location of warning signs for escalators. It is anticipated that this revision will be approved some time before the end of the year.

However, the Commission has noted that the current A 17.1 may be inadequate in two other respects. The injury data involving escalators suggest that the severity of injuries suffered once a foot entrapment occurs may be related to the duration of entrapment and the distance the victim is dragged along the length of the escalator before the escalator stops. A 17.1 presently requires one automatic shutoff device (skirt obstruction device) near the lower combplate. Further investigation is needed to determine whether and to what extent increasing the number of skirt obstruction devices on an escalator will reduce the severity of entrapment injuries. In addition, the maximum ¼" side clearance (between the step and the balustrade) permitted by the ANSI code may be too large to prevent many entrapment accidents.

The Commission has carefully considered the matters raised in the petition and the injury and technical data submitted by the staff. Based on this information, the Commission concludes that considering that millions of consumers use escalators daily, the injury data are insufficient to indicate that escalators present an unreasonable risk of injury. Accordingly, the Commission has denied the petition. In reaching this decision, the Commission considered the relative priority of the risk of injury associated with escalators in the context of Commission resources available for rulemaking for all hazardous consumer products.

The Commission recognizes, however, that skirt obstruction devices and allowable side clearance may be factors in the number and severity of entrapment injuries. Therefore, the Commission has indicated an interest in the staff encouraging an industry effort to determine whether skirt obstruction devices capable of detecting entrapment along the entire length of an escalator, and whether less clearance than that currently permitted by A 17.1 would appreciably reduce the number and severity of these injuries. If a determination is made that the presence of more obstruction devices and less side clearance would result in a significant reduction in number and severity of entrapment injuries, Commission would then encourage and monitor appropriate amendments of ANSI A 17.1.

Copies of the petition and the staff briefing package to the Commission on the petition may be obtained from the Office of the Secretary, Consumer Product Safety Commission, 1111 18th Street NW., Washington, D.C. 20207.

Dated: October 10, 1978.

SADYE E. DUNN,
Secretary, Consumer Product Safety Commission.

[FR Doc. 78-29003 Filed 10-12-78; 8:45 am]

EXHIBIT J00038

The Sun : Sunday, July 21, 1996 : Page 3A

Federal government agency seeks tougher standards on escalator safety

BOSTON GLOBE

The federal government, in a reversal of a long-standing position, has determined that escalators pose a special threat to children and is pushing for an overhaul of most of the country's 30,000 escalators.

The U.S. Consumer Product Safety Commission concluded that escalators can be made less hazardous to children with the addition of safety devices that have been on the market but were never before required, according to documents obtained by the *Globe*.

"All of this information suggests that regular occurrences of entrapment, particularly of the legs and feet of small children, can be almost completely eliminated by the installation of aftermarket safety devices," the agency wrote in a letter this month to the chairman of the committee that sets the national escalator safety code.

The agency is calling for tougher standards for new equipment, saying that a redesign of escalators could "reduce or eliminate many of the other hazards as well."

Safety commission spokesman Rick Frost said the agency is most concerned about the gap between the moving stair and the sidewall on an escalator. The agency estimates that about 1,000 people a year seek emergency treatment after a body part or shoe is sucked into that gap. Of that number, half are children under 5, the agency said.

An estimated 7,300 people sought emergency-room treatment for escalator injuries in 1994.

TAB B

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: JAN 7 2000

TO : Patricia Hackett, Project Manager
Directorate for Engineering Sciences

THROUGH: Susan Ahmed, Ph.D.
Associate Executive Director, Directorate for Epidemiology
Russell Roegner, Ph.D. RR
Director, Division of Hazard Analysis

FROM : Deborah K. Tinsworth, EPHA DKT
Joyce McDonald, EPHA DKT for JEM

SUBJECT : Deaths and Injuries Associated with Escalators

This memorandum provides information on deaths and injuries associated with escalators, in support of U.S. Consumer Product Safety Commission (CPSC) activities related to Petition CP 97-1. This petition requested the development of a mandatory standard for escalators that would address the risks of serious injuries resulting from entrapment of feet, toes, and other body parts in openings between the moving stairs and stationary sidewalls (i.e., the "skirts") of escalators.

DEATHS

Since 1985, CPSC received reports of 27 deaths associated with escalators (Table 1). Of these, 21 involved falls, 4 involved clothing entanglement in escalator comb plates, 1 involved electrocution from a defective light fixture along an escalator, and 1 involved a victim falling through an escalator and becoming crushed. Of those fatally injured, 1 victim was 3-years-old, 11 were between the ages of 24 and 64, 14 were over 65 years of age, and one was described as an "adult." Twelve victims were females and 15 were males.

INJURIES

From 1994 through 1998, there was an estimated average of 5,800 escalator-related injuries treated annually in U.S. hospital emergency rooms, based on data from CPSC's National Electronic Injury Surveillance System (NEISS) (Table 2). Children younger than 15 and persons 65 and older were the victims in over 40 percent of the injuries. However, these age groups represent only about 20 percent of the U.S. population.

Table 1
Escalators: Deaths Reported to CPSC, January 1985-December 1, 1999

Year	Number of Deaths	Hazard Pattern
Total	27	Falls (21), Clothing Entanglement (4), Electrocution (1), Crushing (1)
1999	2	Falls
1998	1	Clothing Entanglement
1997	2	Clothing Entanglement (1), Fall (1)
1996	3	Falls
1995	0	-
1994	1	Fall
1993	1	Fall
1992	1	Fall
1991	5	Falls
1990	4	Falls
1989	1	Clothing Entanglement
1988	0	-
1987	1	Fell into open escalator; crushed
1986	3	Falls (2), Electrocution (1)
1985	2	Clothing Entanglement (1), Fall (1)

Source: IPII, DCRT, INDP Data Files, January 1985-December 1, 1999
U.S. Consumer Product Safety Commission/EPHA

Table 2
Escalators: Estimated Annual Average Number of Emergency Room-Treated Injuries and Yearly Totals of Injuries, by Age of Victim (1994-1998)

		Age of Victim (in years)			
Year	Total	< 5	5 - 14	15 - 64	65+
Annual Average	5,800*	900	800	2,300	1,800
1998	7,000	900	900	3,200	2,000
1997	6,500	900	800	2,600	2,100
1996	5,000	800	600	1,900	1,800
1995	4,800	800	700	1,700	1,500
1994	5,900	1,100	900	2,300	1,600
*Cells may not add up to totals due to rounding.					

Source: National Electronic Injury Surveillance System (NEISS), 1994-1998
U.S. Consumer Product Safety Commission/EPHA

Data for 1998 were examined in more detail to provide further information on the nature of escalator injuries. In that year, there were an estimated 7,000 escalator-related injuries treated in U.S. hospital emergency rooms (Table 3).[1] Over one-third (36 percent) of the injuries were to the leg/foot area. This was followed by the arm/hand area, with about 28 percent of the injuries; the head/face area, with about 17 percent of the injuries; the lower trunk, with about 12 percent of the injuries; and other locations, with about 7 percent of the injuries.[2]

The majority of injuries appeared to be relatively minor, and included such diagnoses as contusions/abrasions (34 percent), lacerations (26 percent), and strains/sprains (23 percent). However, about 13 percent of the injuries involved diagnoses that could be judged as potentially serious, such as fractures, internal injuries, dislocations, concussions, avulsions, crushing, and hematomas. Over 97 percent of the victims were treated and released.

Almost three-fourths of the injuries (5,000) occurred as a result of falls on the escalator. About 1,200 were caused by hands, feet, clothing, or shoes becoming caught in escalators, although in most cases data were not available in sufficient detail to determine what part of the escalator was involved. The sample sizes were not large enough to compare the severity of entrapment injuries to injuries associated with other hazard patterns. The remaining 900 injuries primarily involved minor injuries from non-specified contact with the escalator.

The hazard patterns associated with these injuries appear to be age-related. Among children under 15 years of age, entrapment accounted for about one-half of the injuries (48 percent). For older victims, this hazard pattern was associated with less than ten percent of the injuries.

Table 3
Escalators: Estimated Number of Emergency Room-Treated Injuries by Age of Victim and Type of Hazard, 1998

Age (in years)	Hazard Pattern			
	Total	Falls	Body Part, Clothing or Shoe Caught*	Other
Total	7,000**	5,000	1,200	900
< 5	900	400	400	100
5 – 14	900	300	400	100
15 – 64	3,200	2,500	300	400
65 +	2,000	1,800	<100	200

* Location of entrapment was not reported in most cases.
**Cells may not add up to totals due to rounding.

Source: National Electronic Injury Surveillance System (NEISS), 1998
U.S. Consumer Product Safety Commission/EPHA

[1] 95% CI = 4,200 to 9,800 injuries

[2] The relative frequency of injury to certain parts of the body may be of interest in evaluating the adequacy of test methods developed to address entrapment hazards. Specifically, these include injuries to the lower leg, including the calf (570 injuries, of which about 75 involved entrapment); hand/finger (890 injuries, of which about 590 involved entrapment); and foot/toe (460 injuries, of which about 270 involved entrapment). Please note, however, that these estimates are based on very small sample sizes and may be subject to a large degree of variation.

Where reported, injuries most frequently occurred in shopping malls or department stores. Injuries were also reported to have occurred in airports, hospitals, subway systems, ball parks, and racetracks.

OTHER INCIDENT DATA

Review of CPSC's files of newspaper clippings, consumer complaints, in-depth investigations, and other data received from 1990 through November 1999 revealed reports of 79 non-fatal escalator-related incidents (fatal incidents were included in the count of deaths above). These incidents involved 99 victims, although it was reported that six of these victims were not injured (e.g., such as when a shoe became entrapped, but extracted without injury). While these incident reports are not a complete count or a statistically representative sample of all escalator incidents that occurred during this time period, they nevertheless provide information about the circumstances involved in some escalator-related injuries.

Of the 99 victims, 68 were involved in entrapment incidents involving body parts, clothing, or shoes. In a number of cases, entrapment was reported to have occurred after a victim fell. In 17 of the entrapment cases, amputation of fingers or toes was reported. In almost one-half (33) of the entrapment cases, the victim was younger than 5 years. Almost all (60) of the entrapment victims were younger than 15. In the 26 non-fatal entrapment cases for which an in-depth investigation was completed, most incidents occurred when the victim was going in the "down" direction. When footwear was involved, it was most often reported to be a tennis or athletic shoe. Entrapment most often occurred between the escalator skirt and step, although several cases involved entrapment within the comb plate at the end of the escalator. Details were generally unavailable as to the age of the escalator, maintenance history, or dimensions of the area of entrapment. Shopping malls were the most frequently reported location of occurrence.

An additional 27 victims were reported to have fallen on the escalator, and in 4 cases, other or unknown circumstances were involved.

EVALUATION OF COMMENTS RECEIVED IN RESPONSE TO PETITION

Three respondents, including two safety consultants and a law firm, provided information on escalator-related injuries from studies or compilations of data to illustrate the extent and nature of the problem, and support the need for mandatory requirements. Three other respondents, including two trade/industry organizations and a manufacturer, suggested that escalators are one of the safest modes of transportation, considering their extensive use. A trade/industry group indicated that the available data do not show the cause of injuries, and that many incidents may involve misuse and unsafe behavior. A safety consultant disputed the petitioners' claim that there has been a 5,000 percent annual increase in injuries in recent years.

The studies, both foreign and domestic, and compilations of data that were presented by individuals responding to the petition identified the entrapment problem, and presented case studies to describe specific cases. However, the data did not quantify the extent of the national problem of entrapment in escalators.

While the risk of injury may be low relative to the extensive use of escalators, it appears that the risks, particularly entrapment, are highest for the very young. While most injuries are relatively minor, serious injuries do occur. For some injuries associated with entrapment, such as amputations, the long-term consequences to an individual can be devastating.

Review of incident data associated with escalators has revealed little evidence that misuse and improper behavior are involved in many escalator incidents. However, products that are used as extensively as escalators should be designed to be safe under diverse conditions of use and reasonably foreseeable misuse. For example, it seems reasonable to expect that expected behaviors, such as a person standing too close to the skirt, should not have serious injury consequences.

The petitioners' allegation that there has been a 5,000 percent increase in injuries since 1977 was incorrect. In deriving their estimate, the petitioners used NEISS data taken from a 1978 Federal Register notice denying the 1978 escalator petition. In that notice, the CPSC staff reported that a search of NEISS identified 125 escalator injuries in a 15-month period. However, NEISS is a system for estimating the size of a problem on a national scale. The number of incidents used, 125, was the sample count for reports from NEISS hospitals, not the national estimate. The petitioners thus based their analysis on a comparison of this sample count to a recent national estimate. This is an incorrect comparison.

TAB C

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: January 28, 2000

TO : Patricia L. Hackett, ES
Project Manager, Escalator Petition, CP 97-1

THROUGH: Warren J. Prunella, AED, EC

FROM : Marcia P. Robins, EC

SUBJECT : Economic Considerations: Petition CP 97-1 Requesting Development of a Mandatory Safety Standard for Escalators

The attached report provides a review of the economic considerations associated with the petition requesting the development of mandatory safety standards for escalators.

Economic Considerations: Petition CP 97-1 Requesting Development Of a Mandatory Safety Standard for Escalators

The U.S. Consumer Product Safety Commission (CPSC) received a petition on April 9, 1997, from Scott and Diana Anderson requesting the development of a standard containing requirements to prevent entrapment of body parts in openings between the moving stairs and the sides of escalators. The petitioners requested mandatory design changes that will close the gap between the moving stair (step) and the sidewall (skirt) of the escalator. Closing the gap is expected to prevent certain entrapment accidents. The petitioners also requested that the public be notified of the types of accidents than can occur while riding an escalator and that warning signs that will educate riders be created. The Commission solicited written comments concerning the petition in a notice published in the *Federal Register* (FR) on May 22, 1997.

This report is based on information readily available to staff. Comments were provided in response to the FR notice. Other information came from meetings and communications with the National Elevator Industry, Inc. (NEII) a trade association representing escalator manufacturers, several member manufacturers, and staff from Arthur D. Little (ADL), a contractor hired by NEII to develop performance standards to address escalator step/skirt entrapments. The report describes the escalator market, estimates the societal costs of entrapment injuries, describes new voluntary performance standards, identifies some devices to prevent step/skirt entrapments, and estimates the costs of purchasing and installing two devices.

Escalator Market

The American Society of Mechanical Engineers (ASME) A 17 Elevator and Escalator Code Committee develops voluntary standards for escalator installations and maintenance. The committee defines an escalator as a power-driven, continuous inclined stairway used for raising or lowering passengers. The U.S. market for escalators is dominated by a few multi-national companies. Most, if not all, of these companies provide maintenance services and some also provide after-market safety devices of various kinds. In addition, there are firms that remove and recondition old escalators for installation in new locations, firms that provide repair and modernization services for existing equipment, and firms that supply replacement parts. Other firms provide step cleaning and polishing equipment, safety devices, signage, and announcers with audible safety messages. The owner/operator of an escalator is responsible for its maintenance and continued compliance with the manufacturer's specifications and ASME requirements.

Escalators are often prefabricated and shipped to the installation site where they are reassembled and installed. A typical escalator used in a two-story department store travels a one-floor height and is constructed with the running gear driven by a single drive shaft at a terminal. Escalators used in mass transit systems often travel distances of more than one floor and are constructed with multiple modular units that are driven by one or more drive units; some span a distance of over 200 feet.

Escalators are produced for installation in structures such as office buildings, shopping malls, multi-level retail stores, hotels, and mass transit systems. In addition, escalators are used in college and university buildings, sports stadiums, and cruise ships. Based on aggregated confidential data recently provided by several escalator manufacturers, staff estimates that roughly 40% of escalators are located in retail locations, 23% are in office complexes, at least 13% are in transportation settings, and 8% are found in short-term residences such as hospitals and hotels. Escalators are also used in theaters, stadiums, parking garages, schools, churches, and other locations.

Sales of escalators since 1980, as reported by the NEII, amount to over 18,500 units.[1] Table I provides a breakout of NEII-reported escalator sales from 1980 to 1998. There is no information as to the number of replacement units represented in the sales data.

Table I
NEII-Reported Escalator Sales[2]
1980-1998

Years	Units
1980-1984	3,428
1985-1989	5,197
1990-1994	4,958
1995-1998	4,938

The expected product life of an escalator depends upon its location, maintenance, and use. According to an industry spokesperson, a properly maintained indoor escalator may last 30 or more years. The expected product life of an outdoor escalator, such as one used in a transit system, may be closer to about 15-20 years because of its continuous operation (20 or more hours per day) and the adverse weather conditions to which it is frequently exposed.

The cost of an escalator varies according to its features, length, and manufacturer. Some anecdotal data on escalator prices are available. According to a newspaper article, a new escalator could be purchased in 1986 for approximately $150,000.[3] The *Washington Post* (June 19, 1992) reported a proposed installation of three new escalators for a Washington D.C. metro station at an estimated cost of about $1 million. These units were said to carry heavier loads, last longer, require less maintenance, and have a step/skirt gap that was smaller than existing units.

[1]NEII data represent a large portion of industry sales. However, total sales may be understated because all manufacturers may not have been association members or supplying escalators in the U.S. market for all years data were reported.
[2] *The Elevator World Source*, 1999-2000.
[3] *Walla Walla Union-Bulletin*, April 13, 1986.

An article in *Elevator World* (November 1997) reported the purchase by San Francisco's BART system of 19 new heavy-duty escalators at a cost of $550,000 each. The cost is reported to include annual maintenance, spare parts, and installation.

The number of escalators currently in use is estimated at 30,000 according to an NEII representative. This same estimate appears in *The Elevator World Source* for 1997-1998, 1998-1999, and again for 1999-2000, citing NEII-provided data. While the estimate of 30,000 escalators in use seems generally consistent with the sales data since 1980, it should be not be viewed as a precise estimate, but rather as an approximation.

Societal Cost of Step/Skirt Entrapments

Entrapment injuries occur when clothing or a body part is caught at the upper or lower combplate or between the step and skirt of the escalator. The petition specifically addresses step/skirt entrapments. Injuries from these entrapments typically involve hands and fingers, and legs, feet, and toes. These injuries include amputation of fingers and toes, lacerations, avulsions (a tearing away or separation of skin and/or bones), and degloving (removal of skin and subcutaneous tissue) of the extremities. Long term effects of the injuries include permanent scarring, nerve damage and limb deformities .

The possible benefits of an escalator designed to reduce the escalator step/skirt gap can be estimated from a recent study of emergency room injuries involving escalators. [4] There were an estimated 7,000 emergency room-treated injuries involving escalators in 1998. Of these, an estimated 900 (13 %) involved children under age 5, and another 900 (13 %) involved children age 5 through 14. The remaining 5,200 injuries (74 %) involved passengers over the age of 14.

Of the 7,000 total injuries, about 1,200 (17 %) involved entrapment. Children were more likely than older passengers to sustain entrapment injuries. Almost one-half of the 900 injuries involving children under age 5 resulted from entrapment. In contrast, only about 800 (13 %) of the escalator injuries to all victims over age 5 involved entrapment. Total estimated societal costs for the 7,000 non-fatal escalator injuries in 1998 were about $ 85.5 million, according to the CPSC Injury Cost Model. Societal costs associated with all entrapments accounted for an estimated $ 14.5 million (17% x $85.5 million); costs associated with injuries specifically attributed to step/skirt entrapments are unknown.

The EP memo also reported 4 deaths due to combplate entrapments during the 15-year period from 1985 to 1999. However, the entrapment deaths due to these entrapments would not be addressed by reducing the side/skirt gap.

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[4] Memo from Deborah K. Tinsworth and Joyce McDonald, EP to Patricia L. Hackett, Project Manager, January 2000. (Tab B)

Proposed Technical Revisions to the ASME Escalator Codes

An entrapment potential exists when an object such as a hand or a foot that is in contact with the escalator skirt ceases to slide and is caught in the opening or gap between the skirt and the step. Based on the findings of an ADL study, NEII proposed a Technical Revisions (TR) to the ASME A 17 escalator codes affecting the gap.[5] The recommended TR includes a performance standard based on an Escalator Step/Skirt Performance Index developed by ADL. The Index values range from 0.0 to 1.0 and represent the relative potential for entrapment of an object. It is based on measured values of a "loaded gap", which considers factors such as skirt panel stiffness, gap size, and step movement along with the "coefficient of friction" (COF) of the escalator skirt panel and an object on a moving escalator. The COF depends upon factors such as skirt panel material, surface finish and condition, and applied friction-reducing materials. A lower Index number represents a lower potential for entrapment. A technical discussion of the performance Index is provided in a memo from ES.[6]

The Index value for an escalator is determined using ADL-developed testing procedures and a measuring tool designed specifically for the purpose.[7] Industry representatives are working with prospective tool manufacturers to develop a tool for use in determining the Index value. The measuring tool is estimated to cost about $1,000 per unit and production is expected to be possible with the next 6 months.

Index requirements will differ for new and existing escalators (i.e., those installed before and after the adoption date of the TR). A new escalator with an Index of 0.15 or less will meet the standard; with an Index of 0.15 to 0.25 or greater, a skirt deflector is required.[8] New escalators with an Index value of over 0.25 will be considered out of compliance. Existing escalators will have somewhat different requirements. They too, will meet the standard with an Index of 0.15. However, a deflector will be required if the Index value is 0.15 to 0.40. An existing escalator with an Index value greater than 0.4 will be considered out of compliance.

According to an NEII spokesperson, the members of the NEII fully support the TR to the ASME escalator code. Given current production practices, the the impact on manufacturers supplying new escalators may be minimal, perhaps requiring only a minor change in the design of some new escalator units or a change in skirt panel fabricating materials. New escalators from at least one manufacturer meet the proposed performance Index without the need of a deflector device.

Existing escalators will be affected if local jurisdictions adopt the ASME code changes. The adoption of these changes on the part of local jurisdictions is voluntary. Escalator owners will need to test existing escalators and provide retrofits to bring an unknown number of

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[5] Letter from E.A. Donohue, NEII to G. Burdeshaw, ASME A 17 Main Committee, September 16, 1999.
[6] Memo from Scott Snyder, ES, to Patricia L. Hackett, Project Manager, March 2000. (Tab F)
[7] Testing procedures are specified in the TR.
[8] NEII defines a deflector as "a device which provides a means of deflecting the feet of riders away from the feet of riders away from the step/skirt panel interface".

escalators into compliance. For example, a deflector device can be mounted on the skirt panel to alert riders to their close proximity to the panel. The use of a skirt-mounted deflector device and its placement is specified in the proposed TR. The 1998 cost of such a device is estimated at about $2,800 for a single unit escalator such as used in a department store. A device that reduces the step/skirt gap can be attached to the escalator step. In 1998, the estimated cost per step was $58 to $66 (just under $3,800 to almost $4,300) for an average 65 step escalator. There are additional labor costs associated with either device. Labor costs vary by locale depending upon union pay rates and in 1996 ranged from about $38/hour to about $61/hour (including fringe benefits) for a two person mechanic/helper team. On average, it takes about 8 to 10 hours to install either device on an escalator. Other methods that can be used to reduce the Index include coatings that lower the likelihood of entrapment of clothing and footwear that may rub against the skirt panel can be applied to the surface of the escalator skirt thereby reducing the COF. There are also guidance systems that prevent side-to-side movement of escalator steps and keep the steps running in a straight path.

Since the adoption of ASME code changes on the part of local jurisdictions is voluntary, the NEII plans work with the National Association of Elevator Safety Authorities (NAESA) to meet this goal. The NEII also plans to sponsor an escalator safety program that will target building owners, maintenance contractors, inspection authorities and elevator consultants. The program will stress the importance of escalator maintenance and provide information about new code requirements.

TAB D

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

Memorandum **July 14, 2000**

TO: for David Walden, Acting Associate Executive Director for Engineering Sciences (ES)

THROUGH: Nicholas V. Marchica, Director, Division of Mechanical Engineering (ESME), Directorate for Engineering Sciences (ES)

FROM: Patricia Hackett, Division of Mechanical Engineering (ESME), Directorate for Engineering Sciences (ES)

SUBJECT: Engineering Overview of Escalator Safety Codes and Standards

Background

This memorandum provides a discussion of the current escalator code requirements and the proposed changes to the code from an engineering point of view. In addition, the study performed by Arthur D. Little (ADL) and how it contributed to the proposed code changes will be reviewed.

From a design standard, most escalators installed in the U.S. are generally similar; they have moving steps between stationary sidewalls, or skirts (see Figure 1).

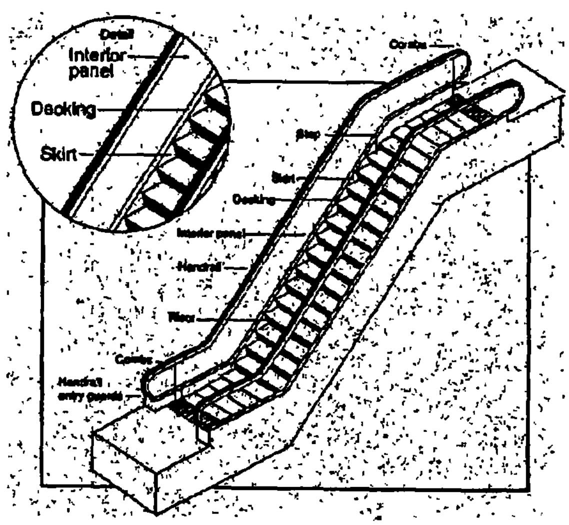

Figure 1:
Basic Escalator Design

With this basic design, a small gap between the steps and the skirts is needed, so that the steps do not contact the skirts and cause damage to the escalator. A sidewall entrapment can occur when a small soft object, such as a shoe or a finger, is placed at the opening of the gap and against the skirt. As the step continues to move, the friction between the object and the skirt could draw the soft object into the gap, causing entrapment and possible injury.

Escalator Codes and Standards Overview

U.S. Safety Codes

Escalator safety requirements in the United States are contained in safety codes that are published by the American Society of Mechanical Engineers (ASME) under the auspices of the American National Standards Institute (ANSI). This is a voluntary standard that is maintained and updated by a working committee who meet on a regular basis. The escalator safety code, ANSI/ASME A17 "Safety Code for Escalators and Elevators," has three parts:

1. A17.1, for new installations and some existing escalators that have been altered;
2. A17.2, for inspectors, more specifically, A17.2.3, for escalator inspectors; and
3. A17.3, for existing installations.

The latest version of A17.1 was published in 1996. The next new version for A17.1 is dated 2000 and will be published at the end of this year. This version has an effective date of one year after publication. Each year between versions, an addendum is published if there are any changes approved by the A17 committee. For example, A17.1a-1997, A17.1b-1998 and A17.1c-1999 were published in 1997, 1998 and 1999 respectively. An addendum becomes effective 6 months after publication.

The latest version of A17.2.3 was published in 1998 and the latest version of A17.3 was published in 1996.

Model Building Codes in the U.S.

Prior to the year 2000, the United States had three model building codes:

1. Southern Building Code Congress International (SBCCI), which publishes the Standard Building Codes (SBC);
2. Building Officials and Code Administrators International (BOCA), which publishes the National Building Codes (NBC); and
3. International Conference of Building Officials (ICBO), which publishes the Uniform Building Codes (UBC).

Typically, state and/or local jurisdictions adopted one of the building codes, in whole or in part, through legislation. These building codes contain numerous voluntary standards that cover a broad spectrum of areas. For conveying systems, including escalators, these building codes all refer to a particular version of A17.

In March 2000, a new International Building Code (IBC) was issued in order to harmonize the three U.S. building codes. The IBC was first drafted in 1997 by representatives of BOCA, ICBO and SBCCI. Their intent was to draft a comprehensive set of regulations for building systems consistent with and inclusive of the scope of the existing model codes. This code will serve as a replacement to the other three model codes. Section 3001.2, in Chapter 30 of the IBC states that all conveying systems shall conform to ASME A17.1.

When adopted at the state or local level, the building code become mandatory. Adoption of these codes is the most common method for how jurisdictions impose mandatory safety requirements for escalators. Enforcement of these mandatory requirements is also done at the state or local level.

International Safety Codes

There are at least five International safety codes and standards for escalators:

1. Canada National Standard Safety Code for Elevators, Escalators, Moving Walks and Freight Platform Lifts,
2. European Standard Safety Rules for the Construction and Installation of Escalators and Passenger Conveyors,
3. International Standard's Escalators-Building Dimension Code,
4. Chinese National Standard's Testing Standard for Elevator, Escalator and Dumbwaiter, and
5. Japanese Industrial Standard's Inspection Standard of Elevator, Escalator and Dumbwaiter.

The Canadian, European and Japanese codes contain step-to-skirt gap requirements and Caution, Safety and/or Warning sign requirements; the requirements are similar to the A17.1 requirements. There are no step-to-skirt gap requirements or warning sign requirements in the International and Chinese codes.

A17.1 Step/Skirt Entrapment Code Requirements

The A17.1-1996 safety code contains several requirements that relate to step/skirt entrapment potential.

Rule 805.3f, Skirt Obstruction Device, is a requirement to shut down an escalator if sidewall entrapment occurs. These safety devices are generally in the form of switches, which are located behind the skirt and are activated when the skirt is displaced. This may occur as a result of kicking the skirt, or from its displacement. When an object, such as shoe or finger, becomes entrapped between the step and skirt, it causes the skirt to move away from the step. This then causes the skirt to contact the safety switch, which suddenly stops the escalator. In the current code, skirt obstruction devices, are required by the A17 safety code at the top and bottom of an escalator.

Directly related to the issue of safety switches is skirt panel deflection. Rule 802.3f (2) states, "Skirt panels shall not deflect more than 1/16 in. (1.6 mm) under a force 150 lbf (667 N)." If an escalator skirt panel easily deflects, there are some possible problems:

- entrapped objects can get pulled in deeper, causing more serious injuries, and
- there is a greater chance that the safety switches will be accidentally activated due to unintentional contact with a sidewall. Stopping a moving escalator can also cause injuries as a result of people losing their balance and falling.

Part (3) of this same rule pertains to the skirt's coefficient of friction, which can also effect entrapment potential. It reads as follows: 'The exposed surfaces of the skirt panels adjacent to the steps shall be smooth and made from a low friction material or treated with a friction reducing material".

Finally, the current A17.1 code dictates a maximum allowable gap between the step and the skirt; Rule 802.3e, Clearance Between Skirt and Step, states "The clearance on each side of the steps between the step tread and the adjacent skirt panel shall not be more than 3/16 in. (4.8mm)."

Historical A17.1 Code Regulations

The step/skirt clearance requirement in ASME A17.1 during the years 1955 through 1970 was less than 3/16 in. (4.8 mm) with a total for both sides of less than 1/4 in. (6.4 mm). In 1971, the code changed and the new requirement was less conservative, allowing up to 3/8 in. (9.5 mm) on each side. In 1980, the code went back to 3/16 in. (4.8 mm) but had no limitations for both sides. The current code, Fifteenth Edition, ASME A17.1c-1999 has the same requirement. Before 1982, there were no provisions in the code dealing with skirt coefficient of friction (COF). Since 1982, A17.1 has required that skirt panels shall be made from a low friction material or treated with a friction-reducing material. An exact requirement for COF has never been part of the code.

In 1999, a Technical Revision (TR) to the code was submitted to the ASME A17 Working Committee on Escalators for consideration. This TR was submitted by the National Elevator Industry, Inc. (NEII), an escalator industry trade organization which has several major manufacturers as members. The TR is a rewrite of the current code, with regard to step/skirt entrapment requirements. It is the result of a two-year study performed by Arthur D. Little (ADL), on behalf of NEII. ADL was contracted to study issues related to sidewall entrapment, and to determine how to reduce or prevent entrapment incidents.

Industry Research

On May 14, 1996, CPSC staff met with the A17 Main Committee to discuss the issue of escalator safety and, more specifically, sidewall entrapments. At that time, CPSC staff suggested that, rather than simply measuring the gap between the step and skirt, industry should develop a performance requirement to address the sidewall entrapment potential. This performance requirement could then be used to determine whether an existing escalator might pose a potential for entrapment.

As a result of this meeting, the National Elevator Industry, Inc. (NEII), the escalator industry trade organization, contracted with ADL to perform a scientific study of escalator step/skirt entrapment potential and to develop a step/skirt performance index (Index).

The ADL study was conducted in three phases. The first phase was to develop an understanding of the step/skirt entrapment process and the parameters that contribute to this process. In this phase, ADL studied the interaction between humans and escalators that led to escalator entrapments. Several scenarios were developed. Two involved foot/shoe/toe entrapment where (1) the shoe is caught in the gap between the sidewall and the step or (2) the shoe is caught between the sidewall and the riser behind the step where the subject is standing. A third scenario involves calf entrapment when a child is sitting on a step and the calf is positioned against the skirt. The fourth scenario describes hand or finger entrapments. This occurs with a person sitting and then resting a hand on the side of the step near the gap. The scenario may also occur when a person falls on the escalator, then grasps the side of the step with his hands.

ADL's analysis considered the forces involved in entrapments from a theoretical perspective. The entrapment event begins with a body part placed against the skirt. A friction force then decelerates the body part or stops the body part from sliding along the skirt. The body part then either rotates or wedges into the gap between the step and the skirt or the riser and the step. The physics involved require the force exerted by the object to overcome the combined lateral stiffness of the step and skirt panel in order to become entrapped.

The theoretical analysis was tested on two laboratory escalators with simulated objects. These objects were made from plastic and were similar in size to child and adult fingers, children's calves and children's shoes. The testing consisted of placing the object, under a given load, at the gap location; then running the escalator for a prescribed distance. Following the run, an observation as to whether or not the object was entrapped was recorded. Operational parameters on the escalator were varied to determine their influence on the entrapment potential. This phase was completed in July 1998. TAB F contains a report summarizing that work. ADL's Phase I report concluded that several factors were observed to affect the likelihood of entrapment.

Phase II, the development of a step/skirt performance standard based on the potential for step/skirt entrapments, commenced following Phase I. In this phase of work, ADL performed additional testing, using replicas of actual body parts. These objects, all the size of a young child, represented a calf, a foot and a hand. These objects were manufactured by Pacific Research Laboratories, Inc. and consisted of individual polymer bones, foam representing muscle and a separate foam layer representing skin. Similar tests were conducted using the same laboratory escalators that were previously used.

Phase III ran parallel with Phase II and was undertaken to identify and generate concepts for inspection equipment. Phases II and III were completed in August 1999 and a report of the results was supplied to CPSC in September 1999 (see TAB G). Following that work, ADL performed some additional verification testing at the request of CPSC staff. A report outlining the testing was provided to CPSC in January 2000 and is included as TAB H.

The ADL study resulted in the development of a performance requirement to determine an escalator's Step/Skirt Performance Index (Index). The Index was developed to be a universal way to represent the likelihood of sidewall entrapment under simulated use conditions.

Indexes can range from 0.0 to 1.0. The lower the measured index of the escalator, the lower the risk for entrapment. The Index is based on the variables that ADL found to have the greatest influence on entrapment:

1) coefficient of friction (COF) between a moving object and the skirt,
2) step stiffness,
3) skirt stiffness, and
4) the measured gap between the step and the skirt

By having several variables, it allows manufacturers of new escalators, and owner/operators of existing escalators the flexibility of deciding what variable(s) they would modify to address the sidewall entrapment hazard. If an escalator sidewall skirt has a low COF it should allow an item placed up against the skirt to slide with the skirt, and not be pulled back into the gap as quickly, thereby reducing the initiation of the entrapment. If an escalator has a high step stiffness there should be little play in the steps from side to side. And if an escalator has a small gap it would be more difficult for an object to become wedged between the step and the skirt gap.

The Index is calculated based on various parameters measured on the escalator while moving at its rated speed. A test instrument, affixed to a step and operated from the top to the bottom along the incline of the running escalator, is used to measure these parameters. This instrumentation will be capable of measuring the running coefficient of friction (COF) of the skirt. At the same time, another part of this instrumentation would apply a 25-lb force against the skirt and record the gap between the step and the skirt. The purpose of the 25 pounds is to account for excessive wear of any components by keeping the step shifted to the opposite side of the track. By applying the 25 pounds, the stiffness of the step and skirt are taken into account and thus the gap measurement is now considered a "loaded" gap. This measurement is different from what is dictated in the current A17.1 Step/Skirt Gap Requirements. In the current A17 code, the gap refers to a static gap, which is measured while the escalator is at rest and under no load conditions. A static gap will always tend to measure smaller than a loaded gap for the same escalator at a given time.

Analysis of the ADL Study

ADL's report relied on testing data generated over a period of time using several different escalators. Due to the number of variables that exist among escalators, ADL determined that there were 108 unique escalator combinations of variables that could be tested and 21 different object combinations. This results in 2,268 total unique conditions that could be tested. Thus, they decided that it was not practical or necessary to test all of these conditions and instead, used statistical experimental design principles to help focus their testing. ADL ended up running a total of 242 test runs; 158 were unique escalator/object configurations and 84 were repeated tests configurations.

The ADL study appears to be the most thorough and comprehensive technical analysis performed to date with regard to the entrapment issue. Previous code requirements, such as gap sizes and stiffness requirements were determined by experience and practicality. COF requirements have been discussed for 20 years at ASME, but before the Index test procedure was developed, there was no consistent way to test an escalator's COF. Committee members knew it was an important issue, but could never agree on an acceptable value because of the testing problem. Therefore, they simply put in a requirement for lubricated skirt panels, without being specific as to the required COF. With the proposed Index requirements, COF can now be measured and will be indirectly specified in the code. Before the ADL study, scientific research was not undertaken when code changes were recommended. ES staff believes that the Index approach to step/skirt entrapments has great merit. It will reduce entrapments because it reduces the loaded gap.

Proposed Code Changes with Regard to Step/Skirt Entrapments

The TR's submitted by NEII were approved by the A17 main committee in January 2000 and will be incorporated into both the A17.1d-2000 addendum as well as the A17.1-2000 new version of the code. The addendum is expected to be published in October of 2000 and has an effective date of 60 days after publication. The new 2000 version of the code is expected to be published before the end of the year, and will be effective one year after publication. The new code uses the Index as a performance requirement. The installation date of a given escalator determines how the code is applied to that escalator. Table 1 identifies the three time frames to which the Index would apply:

(1) *For new escalators installed before the A17.1d-2000 addendum, and for existing escalators the following would apply:* Escalators with a measured index of more than 0.4 would not be in compliance. Escalators with a measured index more than 0.15 but less than or equal to 0.4 would be in compliance only if they have skirt deflectors installed. In addition, they would be allowed to use skirt lubrication to help keep them in compliance. Escalators with a measured index of 0.15 are in compliance.

(2) *For new escalators installed under the A17.1d-2000 addendum, the following would apply:* Escalators with a measured index of more than 0.4 would not be in compliance. Escalators with a measured index more than 0.15 but less than or equal to 0.4 would be in compliance only if they have skirt deflectors installed. Escalators with a measured index of 0.15 are in compliance.

(3) *For new escalators installed after the A17.1-2000 code becomes effective, the following would apply:* Escalators with a measured index of more than 0.25 would not be in compliance. Escalators with a measured index more than 0.15 but less than or equal to 0.25 would be in compliance only if they have skirt deflectors installed. Escalators with a measured index of 0.15 are in compliance.

A17 Code	Performance Index: Requirements	Skirt Lubrication Allowed	Maximum Loaded Gap Specified
Earlier than A17.1d-2000 and A17.3	<0.15: Skirt Deflector not required between 0.15-0.4: Skirt Deflector required >0.4: Not in compliance	YES	Indirectly (via Index requirement)
A17.1d-2000	<0.15: Skirt Deflector not required between 0.15-0.4: Skirt Deflector required >0.4: Not in compliance	NO	YES
A17.1-2000	<0.15: Skirt Deflector not required between 0.15-0.25: Skirt Deflector required >0.25: Not in compliance	NO	YES

Table 1. Summary of NEII Proposals to the A17 Codes

All new escalators installed under A17.1-2000 will have maximum allowable gaps that are specified in the code in addition to the Index requirements. For the existing escalators and for new escalators installed under A17.1d-2000 addendum, the "Indirectly" under the heading "Maximum Loaded Gap Specified" means that these escalators do not have a maximum specific loaded gap stated in the code. The loaded gap will be physically measured and used to calculate the escalator's Index, which then must meet the code requirements.

The "skirt deflector" in Table 1 refers to a category of deflector designs that are typically attached to the skirt and run the complete length of the escalator. One manufacturer's advertising claims that their product: "has been devised to give a physical warning to any passenger standing too near and to the end of the escalator tread". Figure 2 shows an example of a typical brush type safety deflector.

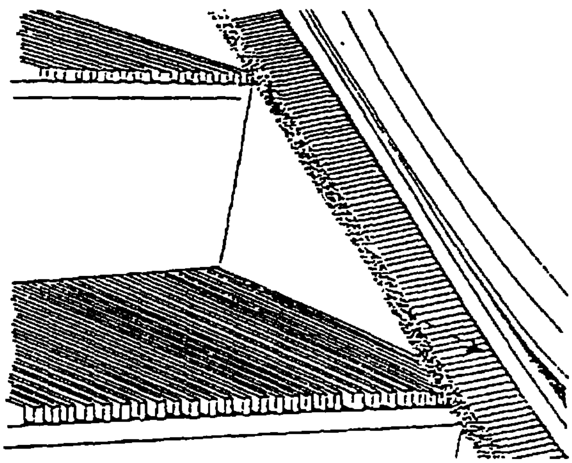

Figure 2. Typical Escalator Safety Deflector

Adoption of the Proposed Code

After the new code is issued, local jurisdictions may adopt it, but are not required to. Since the code only becomes mandatory when and if it is adopted by the local authority having jurisdiction (AHJ's), this can be an obstacle with regard to getting the new code adopted throughout the U.S. The most common form of adoption is through one of the building codes, all of which require compliance with ASME A17.1. Very few jurisdictions in the U.S. do not have a building code. Escalators would generally not be found in such jurisdictions.

Of all the jurisdictions that enforce an elevator/escalator code, only one jurisdiction does not use ASME A17.1, Pennsylvania, and it is in the process of adopting ASME A17.1. Recent legislation requires the Pennsylvania Department of Labor and Industry to adopt A17.1 in lieu of its current code by the end of 2001. This shows a high level of conformity to the A17.1 code across the U.S. The challenge will be to have the AHJ's adopt the new A17.1 code.

In order to encourage quick adoption of the new A17.1 code, NEII has committed to a year-long national escalator safety program that will target building owners, maintenance contractors, inspection authorities and escalator consultants. This program, which stresses the importance of the new code requirements in an effort to encourage adoption, has already commenced and NEII has made two major presentations on the Escalator Index to date. The presentations were made to the National Association of Elevator Safety Authorities (NAESA) and the Escalator section of the American Public Transit Association. Both groups were very supportive. After the presentation, the Board of Directors of NAESA International unanimously passed a resolution supporting the escalator Index and encouraging the AHJ's to adopt the new code.

Manufacturer's Commitment

ES staff requested input from the major U.S. escalator manufacturers with regard to their new production and how it relates to the results of the ADL study. Several manufacturers, Kone Elevators and Escalators, Schindler Elevator Corporation, Otis Elevator Company, Fugitec America and Thyssen Elevator, all who actively participate in the ASME A17 and NEII, provided letters to ES staff in January and February, 2000 that discuss their commitment to producing new escalators that meet the proposed revisions to the code (TAB E). These five manufacturers currently represent 99% of the U.S. market for new escalator sales. All five manufacturers stated that all new production lines will meet or exceed the new code requirements regardless of whether or not it is adopted throughout the U.S. Some of the manufactures added that their current production line already meets the new requirements.

Tab H includes supplemental test results conducted by ADL in late 1999 at two escalator assembly plants on new, standard escalators. The loaded gaps for these new escalators measured 0.091 inch-0.10 inch, or slightly less than 1/8". Thus the static gap would be even smaller. This information indicates that escalator manufacturers are producing new escalators that have gaps that are significantly less than the current voluntary code requirement.

One major escalator manufacturer currently advertises that their new escalators are safer because they can maintain a 1/16 inch static gap. This is achieved by spring loaded guides located under each step which keep the moving steps centered. A 1/16 inch gap is one-third the current voluntary code requirement of 3/16 inch. A smaller gap should reduce the entrapment probability that small shoes or body parts will be caught between the step and skirt. ES Staff has also examined examples of newly installed escalators which have a dramatically reduced step-to-skirt gap. Therefore, it would appear that the industry has already taken the lead in reducing the risk of sidewall entrapments well before the introduction of this proposed Index.

Future Issues for Consideration

When an entrapment occurs, there are factors that contribute to the severity of the injury. For whole body parts to become entrapped, one or more of the escalator components typically become displaced, otherwise hands and feet would not physically fit into a 3/16 inch or smaller gap. Once entrapment is initiated, the object exerts a force between the step and the skirt. This force then tries to shift the step to the other side of the stairway. If there is any play in the step, it will shift. At this point, there is only one remaining component that can physically displace the amount needed to allow body parts into the gap, i.e., the skirt. ES staff believes that one of the contributing factors in determining the severity of the injury is the stiffness of the skirt. Further analysis, with regard to the amount of influence skirt stiffness has on severity, should be considered in order to determine if increasing the code stiffness requirements has merit.

Another issue that should be explored deals with calf entrapments. The ADL data suggest that the potential for hand and feet entrapments is greatly reduced when the escalator's Index is 0.4 or lower. With calf entrapments, there isn't a lower bound Index that suggests an entrapment free zone. Below an Index of 0.15 they are reduced to some extent, but the data suggest that might be due to the COF as opposed to the actual Index. Between 0.15 and 0.40, the proposed code changes calls for the use of a skirt deflector device. These devices are very successful in reducing calf injuries because they prevent children from placing their calves in the area of entrapment. Thus, for escalators with skirt deflectors, calf entrapments should be eliminated. But, there is a possibility that calf entrapments may still occur on escalators that have an Index of 0.15 or lower, because these escalators do not require the skirt deflector device.

One way to address all calf entrapments is by using brushes on every escalator, regardless of their Index values. But, despite the potential problem with calf injuries as seen across the Index levels in the ADL testing, it should be noted that based on the available NEISS data, calf entrapment injuries are rare. In 1998, they accounted for about 75 of the 7,000 injuries reported through NEISS[1]. Therefore, although calf entrapments may occur on escalators with Index values less than 0.15, there are so few of them, requiring deflectors on all escalators may not be justified solely on this basis. (Note: ES staff is also aware that the State of California is currently considering legislation to require skirt deflectors on all escalators in that state).

Frequency of inspection is another issue that may need to be reexamined with the new code requirements. The Index is based on several variables, including the COF and the "loaded gap." Maintenance professionals have indicated that the COF cannot be held constant over a period of time. Even though the current A17 safety code recommends/requires the use of a friction reducing material, there may be drawbacks to relying solely on a low COF to reduce sidewall entrapments. For example, some lubricants used to lower the coefficient of friction, such as spray-on silicone, readily attract dust and dirt. This could make the skirt more sticky and may increase the coefficient of friction.

In addition, the step/skirt gap will vary due to normal wear and tear. Individually, the COF and the step/skirt gap are also a part of the current safety inspection and test requirements for sidewall

[1] TAB B, NEISS 1998 data, footnote 2.

entrapment. The requirements for the new code are annual inspections. With the Index testing, it is unknown at this time, whether or not this inspection interval will be sufficient.

Manufacturers and maintenance contractors are in the best position to recommend Index testing frequencies for the escalator to be in compliance. One manufacturer/maintenance contractor (Thyssen Elevators) stated in a February 3, 2000 letter to CSPC staff the following: "*Our philosophy at Thyssen Dover Elevator is to provide equipment and services that exceed the requirements of the governing Code wherever we can. As such, we plan to test equipment under our services at an interval that exceeds the minimum annual requirement contained in the proposed Code changes.*"

Summary

Before the staff requested the industry to undertake this work, the entrapment provisions in the standard were limited to a static measurement of the step/skirt gap, a stiffness requirement for the sidewall, and a qualitative statement about the coefficient of friction.

As a result of more than two years of study by ADL, the code has been revised to include the use of a performance Index. This Index takes into consideration several factors, most notably the coefficient of friction and the size of the gap under a 25-pound load. In addition, the sidewall stiffness requirement remains in the code. The Index will provide a means to evaluate escalators with a performance test, for the potential of entrapment. The new test method in the code will, for the first time, require that the escalator be tested along the entire incline portion of both sides while the escalator is moving.

The staff believes that the proposed changes to the escalator safety code, based on the results on the work sponsored by NEII, represent substantial improvements to the code and will adequately reduce the risk of entrapment between the step and the skirt of the escalator.