

# ESTA



ANSI E1.22 - 2016  
Entertainment Technology – Fire Safety  
Curtain System

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**Published by:**

Entertainment Services and Technology Association  
630 Ninth Avenue, Suite 609  
New York, NY 10036  
USA  
Phone: 1-212-244-1505  
Fax: 1-212-244-1502 [standards@esta.org](mailto:standards@esta.org)

## The ESTA Technical Standards Program

The ESTA Technical Standards Program was created to serve the ESTA membership and the entertainment industry in technical standards related matters. The goal of the Program is to take a leading role regarding technology within the entertainment industry by creating recommended practices and standards, monitoring standards issues around the world on behalf of our members, and improving communications and safety within the industry. ESTA works closely with the technical standards efforts of other organizations within our industry, including USITT and VPLT, and PLASA. The Technical Standards Program is accredited by the American National Standards Institute.

The Technical Standards Council (TSC) was established to oversee and coordinate the Technical Standards Program. Made up of individuals experienced in standards-making work from throughout our industry, the Council approves all projects undertaken and assigns them to the appropriate working group. The Technical Standards Council employs a Technical Standards Manager to coordinate the work of the Council and its working groups as well as maintain a “Standards Watch” on behalf of members. Working groups include: Control Protocols, Electrical Power, Floors, Fog and Smoke, Followspot Position, Photometrics, Rigging, and Stage Lifts.

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The Rigging Working Group, which authored this Standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. ESTA is committed to developing consensus-based standards and recommended practices in an open setting.

## Contact Information

### Technical Standards Manager

Karl G. Ruling  
ESTA  
630 Ninth Avenue, Suite 609  
New York, NY 10036  
USA  
1-212-244-1505 [karl.ruling@esta.org](mailto:karl.ruling@esta.org)

### Assistant Technical Standards Manager

Erin Grabe  
ESTA  
630 Ninth Avenue, Suite 609  
New York, NY 10036  
USA  
1-212-244-1505 [erin.grabe@esta.org](mailto:erin.grabe@esta.org)

### Technical Standards Council Chairpersons

Mike Garl  
Mike Garl Consulting LLC  
836 Smoke Creek Rd. Knoxville, TN 37934  
USA  
1-865-389-4371 [mike@mikegarlconsulting.com](mailto:mike@mikegarlconsulting.com)

Mike Wood  
Mike Wood Consulting LLC  
6401 Clairmont Drive  
Austin, TX 78749  
USA  
1-512-288-4916 [mike@mikewoodconsulting.com](mailto:mike@mikewoodconsulting.com)

### Rigging Working Group Co-chairperson

Bill Sapsis  
Sapsis Rigging, Inc.  
1-215-228-0888 [bill@sapsis-rigging.com](mailto:bill@sapsis-rigging.com)

Christine Kaiser  
Syracuse Scenery & Stage Lighting Co., Inc.  
1-315-453-8096  
[ckaiser@syracusescenery.com](mailto:ckaiser@syracusescenery.com)

## Acknowledgments

The Rigging Working Group members when this document was approved by the working group on 11 October 2016 are shown below.

### Voting members:

Mike Adamovich; M.G. McLaren, P.C.; G  
Jesse Adams; Rose Brand; DR  
Tracie Allen; R&M Materials Handling; MP  
Frank Allison; M.G. McLaren, P.C.; G  
Matthew Antonucci; Contract Services Administration Trust Fund; U  
Dana Bartholomew; Foy Inven enterprises, Inc.; CP  
Scott Battaglia; LMG Inc.; DR  
William Beautyman; Limelight Productions, Inc.; DR  
Ian Bevan; Walt Disney Company; U  
Keith Bohn; Keith Bohn; G  
William Bradburn; Aerial Arts, Inc.; U  
Bennett Brian; Reed Rigging Inc.; DR  
Joseph Champelli; Entertainment Project Services, LLC; DE  
Dan Culhane; SECOA; CP  
Bruce Darden; Rigging Innovators, Inc.; CP  
Robert Dean; ZFX Flying Inc.; G  
Jonathan Deull; JSD Projects LLC; U  
Brad Dittmer; Stage Labor of the Ozarks; U  
Russ Dusek; I Weiss; MP  
Don Earl; Earl Girls, Inc.; DR  
Patrick Finn; Wenger Corp.; CP  
Adrian Forbes-Black; Total Structures Inc.; MP  
Mike Garl; Mike Garl Consulting LLC; DE  
Ethan William Gilson; Advanced Lighting and Production Services; U  
Sanford P. Gilzow; Shur-Rig LLC; G  
William B. Gorlin; M.G. McLaren, P.C.; G  
Jerry Gorrell; Theatre Safety Programs; G  
Pat Grenfell; Hoist Sales & Service; DR  
Rod Haney; I.A.T.S.E. Local 891; U  
Tim Hansen; Oasis Stage Werks; DR  
Herb Hart; Columbus McKinnon Corp.; MP  
Jeremy Hodgson; Cirque Du Soleil, Inc.; U  
Donald Hoffend\_III; Avista Designs, LLC; G  
Joseph Jeremy; Show Distribution Group, Inc.; MP  
Ted Jones; Grand Stage; U  
Christine L. Kaiser; Syracuse Scenery & Stage Lighting Co., Inc.; DR  
Jerald Kraft; JTH Lighting Alliance; CP  
Edwin S. Kramer; I.A.T.S.E. Local 1; U  
Kyle Kusmer; Steven Schaefer Associates; G  
Tom Lapp; Cirque Du Soleil, Inc.; U  
Roger Lattin; I.A.T.S.E. Local 728; U  
Jon Lenard; Applied Electronics; MP  
Michael Lichter; Electronic Theatre Controls, Inc.; MP  
Dan Lisowski; University of Wisconsin - Madison; U  
Daniel H. Louis; Theta Consulting LLC; G  
Joseph McGeough; Foy Inven enterprises, Inc.; CP  
Bob McVay; Schuler Shook; DE

Sam Michael; Thern, Inc.; MP  
Steven Michelman; Entertainment Project Services, LLC; DE  
Orestes Mihaly; Production Resource Group; DR  
Jeff T. Miller; Walt Disney Company; U  
Rick Montgomery; R&M Materials Handling; MP  
John P. Moore; Hall Associates Flying Effects; CP  
Reid Neslage; H & H Specialties Inc.; MP  
Jim Niesel; Theatre Projects Consultants, Inc.; DE  
Richard J. Nix; ZFX Flying, Inc.; G  
Shawn Nolan; Production Resource Group; DR  
Tracy Nunnally; Hall Associates Flying Effects; CP  
Jennifer O'Leary; Columbus McKinnon Corp.; MP  
Kimberly Corbett Oates; Schuler Shook; DE  
Carlos Ortega; PSAV Presentation Services; U  
Gregory Orth; WNP Services, Inc.; DR  
Miriam Paschetto; Geiger Engineers; G  
Rocky Paulson; Freeman Companies; DR  
Galen Price; Blue Man Group; U  
Steven Ricks; Electronic Theatre Controls, Inc.; MP  
John Ringelman; Freeman Companies; DR  
Heather Rowe; Contract Services Administration Trust Fund; U  
Bill Sapsis; Sapsis Rigging, Inc.; U  
Peter A. Scheu; Scheu Consulting Services, Inc.; DE  
Chris Schmidt; Freeman Companies; DR  
Joseph S. Schuster; Simpson Gumpertz & Heger; DE  
Steven Serafin; Chubb Group of Insurance Companies; G  
Harold Ike Shippers; Syracuse Scenery & Stage Lighting Co., Inc.; DR  
John C. Snook; Thermotex Industries Inc.; CP  
Russell Solomon; Texas Scenic Company; DR  
Todd Spencer; PSAV Presentation Services; U  
Stephen G. Surratt; Texas Scenic Company; DR  
Peter V. Svitavsky; Wenger Corp.; CP  
Ken Tilson; Columbus McKinnon Corp.; MP  
Will Todd; Milos Group; MP  
James Tomlinson; Team Tomlinson; G  
Elmer Veith; Total Structures, Inc.; MP  
Steve Walker; Steve A. Walker & Associates; G  
Charlie Weiner; Milos Group; MP  
Michael Wells; Xtreme Structures and Fabrication; MP  
Marty Wesstrom; Mountain Productions Inc.; DR  
Jeff Wilkowski; Thern, Inc.; MP  
Max A. Wilson; Applied Electronics; MP  
R. Duane Wilson; Amer. Society of Theatre Consultants; DE  
Stephan Jon Wood; Tait Towers Manufacturing LLC; CP  
Paul Zagajeski; Wenger Corp.; CP

**Observer Members:**

William Ian Auld; Auld Entertainment; U  
Robert Barbagallo; Solotech Inc.; DR  
Roger Barrett; Star Events Group Ltd.; DR  
Roy Bickel; Roy Bickel; G  
Scott M. Blair; Full Throttle Films/ VER; DR

Lee J. Bloch; Bloch Design Group, Inc.; G  
Louis Bradfield; Louis Bradfield; U  
Buddy Braile; North Shore Theatrical Rigging; U  
David M. Campbell; Geiger Engineers; G  
Daniel J. Clark; Clark-Reder Engineering, Inc.; G  
Benjamin Cohen; Chicago Flyhouse Inc.; CP  
Jim Digby; Linkin Park Touring/The Collective; U  
Tim Franklin; Theta Consulting LLC; G  
Tony J. Galuppi; Tony J. Galuppi; U  
James M. Garner; Walt Disney Company; G  
Chris Geisler; Fluid Design Inc.; DE  
Michael P. Gosenski; Rigging Systems LLC; U  
Sean Harding; Port Lighting Systems; G  
Greg Hareld; Kleege Industries; U  
Chris Higgs; Total Solutions Group; G  
Jeremy Hochman; Full Throttle Films/ VER; DR  
Kent H. Jorgensen; IATSE Local 80; G  
Gary Justesen; Oasis Stage Werks; DR  
Nevin Kleege; Kleege Industries; U  
Wendy Manson; Cirque Du Soleil, Inc.; U  
Magali Marcheschi; Polytechnic Montreal; G  
Bartholomew J. Mueller; Recreation Engineering Inc.; DE  
Bob Murphy; Occams Razor Technical Services; G  
Edward A. (Ted) Paget; Electronic Theatre Controls, Inc.; MP  
Michael Patterson; Pook Diemont & Ohl, Inc.; CP  
Kurt Pragman; Pragman Associates, LLC; G  
Mark Riddlesperger; LA ProPoint, Inc.; CP  
Eric Rouse; Denver Center for the Performing Arts; G  
Ford Sellers; Chauvet Lighting; MP  
Steven C. Shaw; Levitating Productions, Inc.; MP  
Q. Brian Sickels; Q. Brian Sickels; G  
Monica Skjonberg; Skjonberg Controls, Inc.; CP  
Ross Taylor; Taylor & Taylor Associates; G  
Stephen Vanciel; IATSE Local 631; U  
Nicholas Gill Wright; I.A.T.S.E. Local 16; G

**Interest category codes:**

CP = Custom-market Producer  
DE = Designer  
DR = Dealer or Rental company  
G = General interest  
MP = Mass-market Producer  
U = User



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## 1 General

### 1.1 Scope

This standard governs the design, materials, fabrication, installation, operation, testing, and maintenance of fire safety curtain systems used for proscenium opening protection.

### 1.2 Purpose

**1.2.1** Fire safety curtain systems shall be used where required by building codes, fire codes, or by the authority having jurisdiction.

**1.2.2** Fire safety curtain systems shall work in conjunction with other building life and fire safety systems. (See Annex note B.1.2.2.)

**1.2.3** Fire safety curtain systems shall protect occupants of the audience area from a fire on stage and shall in combination with other building life and fire safety systems provide occupants of the audience area sufficient time for safe and orderly egress.

**1.2.4** The fire safety curtain shall reduce the transmission of radiant heat, block debris, and contribute to the control of smoke and gas movement for a period of 20 minutes.

**1.2.5** A fire safety curtain is a specialized fire protection system, and its plans and specifications shall be developed in accordance with this standard by qualified persons experienced in the installation, inspection and testing of fire safety curtain assemblies.

### 1.3 Equivalency

The provisions of this standard are not intended to prevent the use of any material or to prohibit any design or method of fabrication not specifically prescribed by this standard, provided that any such alternative material, design or method of fabrication complies with the intent of the provisions of this standard. The quality, strength and effectiveness of all materials and methods of work shall be at least equivalent to those prescribed in this standard.

## 2 Definitions

**2.1 Batten:** A horizontal pipe, tube, or other structural shape in a pocket of or attached to a fire safety curtain.

**2.2 Brail Fire Safety Curtain:** An unframed fire safety curtain that is folded horizontally in an accordion fashion for storage.

**2.3 Brail Fire Safety Curtain System:** A system that opens and closes a brail fire safety curtain.

**2.4 Bumper (Yield Pad):** A filled pocket of fabric located below the bottom batten or bottom member of a frame.

**2.5 Fill:** The set of yarns placed crosswise in the loom, interlaced with the warp, forming the crosswise threads in the fabric. Also known as cross machine direction.

**2.6 Fire Safety Curtain:** The actual barrier including the membrane, structural framing, and attached hardware that closes the proscenium opening.

**2.7 Fire Safety Curtain System:** A fire safety curtain with all required hardware and controls to form a complete, fully operable assembly. (See Annex note B.2.7.)

**2.8 Framed Fire Safety Curtain:** A curtain assembly containing both a rigid perimeter frame and internal members.

**2.9 Labeled:** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**2.10 Listed:** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment, material, or service and meets appropriate designated standards or has been tested and found suitable for a specified purpose.

**2.11 Multi-part Fire Safety Curtain System:** A system that opens and closes multiple fire safety curtains with horizontal overlaps.

**2.12 Noncombustible:** A material that, in the form in which it is used and under the conditions anticipated, will not aid combustion or add appreciable heat to a fire. Materials, when tested in accordance with ASTM E136-12 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C, and conforming to the criteria contained in Section 8 of the referenced standard, are considered as noncombustible.

**2.13 Pressure Differential:** The force exerted over the fire safety curtain system caused by the difference in air pressure on each side of the curtain.

**2.14 Proscenium Opening:** The main opening in the proscenium wall used for viewing performances.

**2.15 Proscenium Wall:** The wall that separates the stage from the audience area.

**2.16 Qualified Person:** A person who, by possession of a recognized degree or certificate of professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

**2.17 Straight Lift Fire Safety Curtain System:** A system that opens and closes a fire safety curtain as one flat panel without bending or folding.

**2.18 Unframed Fire Safety Curtain:** A curtain without rigid horizontal members other than the top and bottom battens.

**2.19 Vertical guide pockets (“Smoke Pocket”):** Partial enclosures on both the stage left and stage right sides of the proscenium opening on the proscenium wall that protects the edges and guides of a fire safety curtain system. (See Annex note B.2.19.)

**2.20 Warp:** The set of yarns placed lengthwise in the loom, crossed by and interlaced with the fill, forming the lengthwise threads in the fabric. Also known as machine direction.

### 3 Unframed Fire Safety Curtains

#### 3.1 Identification

Fabric fire safety curtains shall be permanently identified per paragraph 3.3.5 and the fabric shall be listed as complying with the ASTM E119-12a fire tests described in paragraph 3.4. (See Annex note B.3.1.)

#### 3.2 Fabric

**3.2.1** The fabric shall have a tensile strength of not less than 7.14 kg/mm (400 pounds per inch) in both the warp and fill directions as tested in accordance with ASTM D5034-09, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test). (See Annex note B.3.2.1.)

**3.2.2** The fabric shall not lose over 35% of the warp strength when subjected to 50 cycles in accordance with ASTM D4157-13 Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method) using the 100-grit emery paper as the abradant, and using 26.7 newtons (6 pounds) tension and 13.3 newtons (3 pounds) compression force.

**3.2.3** The fabric shall have a smoke density rating of 25 or less, as tested in accordance with ASTM E84-04 Standard Test Method for Surface Burning Characteristics of Building Materials.

**3.2.4** The fabric shall have an air permeability of less than 7.62 cubic meters/min per square meter (25 cfm per sq ft) tested in accordance with ASTM D737-04(2012) Test Method for Air Permeability of Textile Fabrics.

### **3.3 Construction**

**3.3.1** Exposed fabric edges shall be prevented from unraveling and shall not compromise the strength of the fabric. (See Annex note B.3.3.1.)

**3.3.2** The fabric and its seaming shall have a tensile strength at least two times the tension stress resulting from a pressure differential of 95.8 Pa (2 psf) on the fire safety curtain over the area of the proscenium opening.

**3.3.3** Top and bottom pockets shall be sized to permit insertion of battens where required.

**3.3.4** Fire safety curtains shall be guided at the two opposite vertical edges for the full extent of travel.

**3.3.5** The fire safety curtain shall have a label in a location that is visible and convenient for identification by the authority having jurisdiction after installation of the fire safety curtain system. The label shall include the name of the fire safety curtain manufacturer, product or style of fabric, date of manufacture, list of fire tests, and testing agency. Labeling shall also include the name of the Installing contractor, contact information and date of installation.

### **3.4 Testing**

A sample of the fire safety curtain shall be tested in accordance with ASTM E119-12a Standard Test Methods for Fire Tests of Building Construction and Materials procedure applicable to nonbearing walls and partitions for a period of 30 minutes. The sample construction shall replicate the sewing of the full-sized curtain, shall have a minimum of two vertical seams, and a bottom pocket containing a minimum 5.95 kg/m (4 pounds/foot) batten. The sample shall overlap and seal the top and vertical furnace edges. The unexposed surface of the sample shall not glow during the testing procedure, and flame or smoke shall not penetrate the sample. Only the surface cleansing vapors created by the oven's elevating temperatures in the first minutes of the procedure shall be acceptable. Unexposed surface temperature measurements and hose stream testing shall not be required.

## **4 Framed Fire Safety Curtains**

### **4.1 Fire-resistance**

#### **4.1.1 Fire-resistance ratings**

The fire-resistance rating of materials shall be determined in accordance with the test procedures set forth in ASTM E 119-12a for a period of 30 minutes, or in accordance with the alternative methods listed below. Unexposed surface temperature measurements and hose stream testing shall not be required. Where materials, systems or devices that have not been tested as part of a fire-resistance-rated assembly are incorporated into the assembly, sufficient data shall be made available to show that the required fire-resistance rating is not reduced. Materials and methods of construction used to protect joints and penetrations in fire-resistance-rated coverings shall not reduce the required fire-resistance rating. (See Annex note B.4.1.1)

#### **4.1.2 Alternative methods for determining fire resistance**

The application of any of the alternative methods listed in this section shall be based on the fire exposure and acceptance criteria specified in ASTM E 119-12a. The required fire resistance of a building element shall be permitted to be established by any of the following methods or procedures.

**4.1.2.1** Fire-resistance designs documented in approved sources.

**4.1.2.2** Prescriptive designs of fire-resistance-rated building elements as prescribed in Section 721 of the 2012 International Building Code.

**4.1.2.3** Calculations in accordance with Section 722 of the 2012 International Building Code.

**4.1.2.4** Engineering analysis based on a comparison of building element designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E 119-12a.

**4.1.2.5** Alternative protection methods as allowed by Section 1.3.

**4.1.3 Surface-burning characteristics** The fire resistive cover shall have a flame spread index of 75 or less and a smoke developed index of 450 or less when tested in accordance with ASTM E84-13a.

## **4.2 Frame**

**4.2.1** The frame shall be designed to comply with current AISC steel design standards or other applicable standards.

**4.2.2** The slenderness ratio for compression members shall not exceed 200:1.

**4.2.3** The frame shall be braced to maintain its shape and integrity in the event of a single liftline or guide failure.

**4.2.4** The frame shall consist of an assembly of horizontal members, vertical end members, intermediate vertical supports and bracing.

## **4.3 Frame Members**

**4.3.1** Framing shall be noncombustible.

**4.3.2** Steel frame members shall be designed so the maximum combined stresses from gravity loads and a 95.8 Pa (2 psf) pressure applied over the entire curtain surface shall not exceed one third of the frame material's yield strength at room temperature. Other frame materials shall be permitted only when allowable stresses are fully documented by an engineering analysis performed by a qualified person.

**4.3.3** The intermediate vertical members shall brace the horizontal members and provide restraint against lateral buckling.

**4.3.4** Horizontal members shall be spaced to support face material and bracing for end members.

**4.3.5** End members shall have sufficient strength to distribute the lateral forces resulting from the pressure differential to the guide shoes.

**4.3.6** Frame member splices shall develop the full strength of the member.

## **4.4 Guide Assemblies**

**4.4.1** Each vertical edge of the curtain shall have a minimum of two assemblies to guide the frame within its vertical path of travel.

**4.4.2** Guide assemblies shall allow unrestrained expansion of the curtain assembly created by the fire. (See Annex note B.4.4.2)

## **4.5 Fire Resistive Cover Material**

**4.5.1** Either one or both sides of the frame shall be covered with fire resistive materials. Flexible or rigid

cover materials such as glass fiber fabric, steel sheet, insulation, or gypsum, singularly or in combination, shall be selected by a qualified person to meet the temperature and strength criteria.

**4.5.2.** Cover and its attachment shall withstand a minimum horizontal pressure of 95.8 Pa (2 psf) unless higher pressures are required by code.

**4.5.3** The Fire Resistive Cover Material shall have a label in a location that is visible and convenient for identification by the authority having jurisdiction after installation of the fire safety curtain system. The label shall include the name of the fire safety curtain manufacturer, product or style of cover material, date of manufacture, list of fire tests, and testing agency. Labeling shall also include the name of the Installing contractor, contact information and date of installation.

## **5 Opening Proximity**

**5.1** The fire safety curtain in a straight lift fire safety curtain system shall be a maximum of 102 mm (4 inches) from the proscenium wall.

**5.2** The top part of a multi-part fire safety curtain shall be a maximum of 102 mm (4 inches) from the proscenium wall.

**5.3** The fire safety curtain in a brail fire safety curtain system shall be a maximum of 203 mm (8 inches) from the proscenium wall.

**5.4** The distance shall be measured from the stage side of the proscenium wall inside the vertical guide pocket area to the center of the upper batten on unframed curtains; on framed curtains, the measurement shall be made from the stage side of the proscenium wall inside the vertical guide pocket area to the surface nearest the proscenium wall.

## **6 Vertical Edges**

**6.1** The vertical edges of unframed fire safety curtains shall overlap the proscenium wall a minimum of 457 mm (18 inches). The measurement shall be with the curtain closed and without a pressure differential.

**6.2** The vertical edges of framed fire safety curtains shall overlap the proscenium wall a minimum of 152 mm (6 inches). The measurement shall be with the curtain closed and without a pressure differential.

**6.3** The vertical guide pocket shall overlap unframed fire safety curtains a minimum of 305 mm (12 inches).

**6.4** The vertical guide pocket shall overlap framed fire safety curtains a minimum of 152 mm (6 inches).

**6.5** Vertical guide pockets shall be constructed from rolled structural steel sections and minimum 6.3mm (1/4") thick steel plate or equivalent construction.

**6.6** Vertical guide pockets shall protect the vertical edges and guide system of a fire safety curtain from interference between the fire safety curtain and people, stage curtains, scenery, or other items.

**6.7** The vertical guide pockets shall be attached to the proscenium wall and shall not interfere with movement of the fire safety curtain. Vertical guide pockets shall be designed to withstand anticipated loads.

**6.8** Access for servicing the curtain and vertical guide shall be provided by means of a movable or removable panel for a minimum of 3.05 m (10 feet) above the floor for an unframed fire safety curtain and the full height for a framed or brail fire safety curtain when closed.

**6.9** The vertical guide pockets shall extend vertically to protect the entire edge of the fire safety curtain throughout its range of travel and shall include allowance for over-travel.

**6.10** Vertical guide pockets shall be permitted to support guide components.

**6.11** Guides on unframed curtains shall be designed and installed to withstand the forces from a 95.8 Pa (2 psf) pressure differential applied to the fire safety curtain and maintain an overlap of the proscenium wall. (See Annex note B.6.10.)

**6.11.1** Guides shall be spaced no more than 457mm (18 inches) apart.

## **7 Horizontal Edges**

**7.1** Fire safety curtains shall overlap the proscenium wall above the opening by a minimum of 610 mm (24 inches) in the closed position with no pressure differential.

**7.2** Multi-part fire safety curtains with non-continuous edges within the proscenium opening shall overlap each other by a minimum of 610 mm (24 inches) where unframed, and a minimum of 305 mm (12 inches) where framed. The measurement shall be with the curtain closed and without a pressure differential.

## **8 Bumpers**

There shall be a minimum 76.2 mm (3 inches) thick bumper made with an outer covering of the same material as the fire safety curtain fabric, filled with noncombustible materials to a 48.1 kg per cubic meter (3 pound per cubic foot) density. The bumper shall be affixed beneath the bottom frame member of framed fire safety curtains or sewn beneath the bottom batten of unframed fire safety curtains.

## **9 Battens**

**9.1** The top batten in unframed fire safety curtains shall be designed to limit vertical deflection to 1/180 of the span between supports with no pressure differential.

**9.2** The bottom batten in unframed fire safety curtains shall weigh a minimum of 5.43 kg/m (3.65 pounds/foot).

**9.2.1** The bumper shall contact and compress against the stage floor when the curtain is in its deployed position.

## **10 Rigging**

**10.1** Non-emergency opening and closing shall be powered except straight lift unframed fire safety curtain systems for proscenium openings less than (85.9 m<sup>2</sup>) 925 square feet shall be permitted to be unpowered.

**10.2** All lifting and load supporting components shall be fabricated of noncombustible materials.

**10.2.1** Fasteners shall be adequate for the imposed loads at the elevated temperatures listed in ASTM E119 for a duration of 20 minutes.

**10.3** All components shall be installed as recommended by the manufacturer.

**10.4** Rigging shall be designed by a qualified person and installed or supervised by a person who has had his/her knowledge and work experience certified by a third-party acceptable to the Authority Having Jurisdiction.

**10.5** Rigging components, where possible, shall comply with ANSI E1.4-2014 Entertainment Technology - Manual Counterweight Rigging Systems and ANSI E1.6-1 – 2012 Entertainment Technology - Powered Hoist Systems.

**10.6** Framed and unframed fire safety curtains shall be installed with a secondary suspension system (example “stay chains”) attached to structural framing to support the curtain when deployed.

**10.7** Brail fire safety curtains shall be installed with the top batten dead hung with a support system attached to structural framing. This suspension system shall be in addition to the system used for hoisting.

**10.8** Lift line spacing for brail fire safety curtains shall not exceed 2.44 m (8 feet) and the end hoisting lines shall be a maximum of 610 mm (24 inches) from the vertical edge of the curtain.

**10.9** Where a manual winch is used the handle shall not rotate during emergency closing.

## **11 Operation**

**11.1** The fire safety curtain system shall be capable of emergency closing and non-emergency opening and closing.

**11.1.1** Fire safety curtain assemblies shall be designed to operate in emergency and nonemergency conditions for all imposed loads, including dead loads of the assembly, and for a pressure differential of 95.8 Pa (2 psf) on the fire safety curtain over the area of the proscenium opening.

**11.2** Emergency closing shall be initiated by both automatic and manual means independently.

**11.3** Automatic closing shall be initiated only by the detection of fire on stage. Detection shall use electronic heat detectors, sprinkler flow detection, or combination thereof. (See Annex note B.11.3)

**11.3.1** Electronic heat detectors shall be installed in accordance with NFPA 72-2013 National Fire Alarm Code. (See Annex note B.11.3.1.)

**11.3.1.1** Electronic rate of rise detectors shall be rated “Ultra-Fast” with a rating of 9 degrees C (15 degrees F) per minute.

**11.3.1.2** Electronic fixed-temperature heat detectors shall be selected based upon the temperature requirements of the application.

**11.3.2** Sprinkler system flow detection devices shall be installed in accordance with NFPA 13-2013.

**11.4** Manual release systems shall include a minimum of two operator stations that initiate emergency closing.

**11.4.1** A manual release station shall be installed at both sides of the proscenium opening. Stations shall be unobstructed, visible and operable from stage floor level.

**11.4.2** The emergency manual release device shall be painted red per ANSI Z535.1-2006, Safety Color Code.

**11.4.3** Operations requiring cutting or severing a line are not permitted.

**11.4.4** Manual emergency operation shall be accomplished by a single person.

**11.4.5** A sign shall clearly identify the device and its operation. (See Annex note B.11.4.5.)

**11.5** Standby or emergency power per NFPA 70-2014 shall be provided if power is required for emergency closing.



**11.6** Non-emergency closing and opening shall not affect or disable emergency closing systems or devices.

**11.7** Non-emergency operation shall be accomplished by a single person.

**11.8** Non-emergency operation shall require not more than 3 minutes.

**11.9** Where resetting is required after emergency closing or testing, the procedures for resetting shall require no more than two persons. Resetting shall be accomplished without the need for tools, ladders, or other equipment. Use of equipment shall be permitted for replacing and resetting of electrical release devices.

**11.10** In emergency closing, the curtain shall close from any position to the full closed position at an average speed of not less than 0.305 m/second (1 foot/second). The last 2.44 m (8 feet) of travel shall require a minimum of 5 seconds. (See Annex note B.11.10.)

**11.11** Emergency closing speed shall be either governed during the curtain's entire travel, or shall be decelerated for the last 2.44 m (8 feet) of its travel. Deceleration shall be accomplished by dashpot, mechanical brake, or other device. Removing weight from the curtain side or adding weight to the counterweight side is not permitted for achieving deceleration. (See Annex note B.11.11.)

**11.12** All fire safety curtains shall be in the closed position except during events with an audience, rehearsals, technical production activity, or activities on stage that necessitate the curtain be open. (See Annex note B.11.12.)

**11.13** All labeling and signage required in this section shall comply with the requirements of the following recognized national standards:

ANSI Z535.1-2006(R2011), Safety Color Code

ANSI Z535.2-2011, Environmental and Facility Safety Sign

ANSI Z535.3-2011, Criteria for Safety Symbols

ANSI Z535.4-2011, Product Safety Signs and Labels

**11.14** Signs or labels shall be in English. If operating personnel are not English literate, additional signs or labels in the appropriate language shall be provided.

## **12 Testing, Training, Maintenance, Inspection, and Repairs**

### **12.1 Records**

**12.1.1** A log shall be provided with each fire safety curtain system installed. The log shall include the date of installation, name of the installing contractor, instructions for maintenance, testing, manual emergency closing, and manual operation. All tests and maintenance activities shall be recorded in the log. For fire safety curtain systems where the operation is modified, the manual shall be updated or replaced. The log shall be maintained and shall be made available to the authority having jurisdiction for inspection.

**12.1.2** Except for fire safety curtains complying with the prescriptive designs in Annex A, drawings, calculations, or other documentation shall identify the loads applied to the building under normal and emergency operation, including the forces on the curtain guides and the anticipated curtain deflection resulting from a 95.8 Pa (2 psf) pressure differential.

### **12.2 Pre-Acceptance Testing**

**12.2.1** Emergency closing and non-emergency operation shall be demonstrated. The authority having jurisdiction shall be notified of the time and place of the demonstration. The demonstration shall include successfully passing the test for emergency closing a minimum of three consecutive times. All emergency operation devices shall be demonstrated at least once. Manual release of cabling to demonstrate proper operation shall be permitted.

**12.2.2** Prior to final acceptance, the Owner or a designated representative shall be trained by a qualified

person on the operation, maintenance, and testing requirements of the fire safety curtain system.

### **12.3 Periodic User Testing**

The emergency closing of the fire safety curtain system shall be tested at least once every 30 performances but not less than once every three months.

### **12.4 Annual Inspection**

**12.4.1** A qualified person shall inspect the fire safety curtain system at least once a year.

**12.4.2** Inspection shall include complete visual inspection of the curtain, rigging, and both the automatic and manual initiating and release devices.

**12.4.3** Emergency manual closing shall be tested including testing each manual emergency release device at least once.

**12.4.4** The log shall be reviewed by the qualified person.

**12.4.5** The owner or the owner's designated representative shall be trained by a qualified person on the operation, maintenance, and testing requirements of the fire safety curtain system as a part of each annual inspection.

**12.4.6** The authority having jurisdiction shall be notified of the time and place of the annual inspection.

### **12.5 Maintenance**

Devices with finite life spans shall be replaced per the manufacturer's recommendations. Such devices shall include, but not be limited to, batteries, lubricants, fluids, and organic fiber lines.

### **12.6 Repairs**

Unless alternate measures approved by the authority having jurisdiction are in place, deficiencies found that affect the emergency closing of the fire safety curtain system or adversely affect the permeability or performance of the fire safety curtain shall be repaired and user-tested (per 11.2) before the theater is occupied for an event with an audience. Other deficiencies shall be repaired within 30 days. Repairs shall be recorded in the Owner's Log and kept on file by the Owner.

**Annex A****Examples, Not a normative part of the standard**

This Annex contains examples of prescriptive designs based on fire safety curtains and standards commonly used in the United States and is not a part of the requirements of this standard. It is included for informational purposes only. As the understanding and knowledge about fire safety curtain systems increases based on research and experience, dependence on these examples should lessen. The prescriptive designs in this Annex are limited to the design examples and are not general requirements to be applied to all fire safety curtain systems.

**A.1 Fabric Fire Safety Curtain Construction**

**A.1.1** Fabric curtains should be made of continuous vertical strips of fabric sewn together with no horizontal seams.

**A.1.2** All seams and other functional stitching should use a minimum of 25.4 mm (1 inch) wide overlap construction with two rows of lockstitch stitching using flame-resistant thread or an alternative construction with equivalent or superior performance. A sample should be tested per 3.4.

**A.1.3** Vertical edge hems should have a minimum of three layers of fabric. The hem should be of uniform thickness and width where guide members or metal reinforcements are attached.

**A.2 Unframed Straight-lift Fire Safety Curtain Systems**

**A.2.1** For proscenium openings with a maximum width of 15.2 m (50 feet) and a maximum height of 9.14 m (30 feet) and where there is a minimum clear height for the fire safety curtain system of twice the height of the proscenium opening plus 1.52 m (5 feet), an unframed Straight-Lift fire safety curtain system with roller guides should be permitted. Guides should use continuous tracks with captive trolleys or rollers at each vertical edge of the curtain. Trolleys or rollers should be attached to the vertical edges of the fire safety curtain with a minimum of three fasteners. Trolleys or rollers should be spaced not more than 457 mm (18 inches) on center.

**A.2.2** For proscenium openings with a maximum width of 12.8 m (42 feet) and a maximum height of 6.7 m (22 feet) and where there is a minimum clear height for the fire safety curtain system of twice the height of the proscenium opening plus 1.52 m (5 feet), an unframed straight-lift fire safety curtain system with cable spool guides should be permitted. Spool guides should be attached to the vertical edge of the fire safety curtain not more than 457 mm (18 inches) on center.

**A.2.3** There should be metal edge reinforcements fabricated of 16 gauge galvanized steel a minimum of 152 mm (6 inches) wide on both faces of the fire safety curtain, and bolted to each vertical edge hem of the fire safety curtain. The bolts used to attach the guides should also be permitted for attaching the metal reinforcing to the curtain. Fasteners should be minimum 6.35 mm (0.25 inch) diameter SAE J 429 Grade 5.

**A.2.4** The top and bottom battens should be minimum 60 mm O.D. (2 inches nominal) schedule 40 steel pipe.

**A.2.5** Wire rope guides should be minimum 6.35 mm (0.25 inch) diameter at each vertical edge of the curtain, anchored top and bottom.

**A.2.6** Vertical guide pockets should be constructed of steel and should enclose the edge of and overlap the fire safety curtain by a minimum of 305 mm (12 inches) for the full extent of the fire safety curtain throughout its travel plus 305 mm (12 inches). The vertical guide pockets should be a steel channel fastened to the proscenium wall and have a minimum 6.35 mm (0.25 inch) steel plate attached to the other flange or should be a one piece bent 6.35 mm (0.25 inch) steel plate. The vertical guide pocket should be a minimum of 152 mm (6 inches) in depth, measured perpendicular from the proscenium wall. Where a plate is attached to a channel, the attachment should be bolted connections with bolt spacing not greater than 610 mm (24 inches) on center. The vertical guide pockets should be fastened to the proscenium wall constructed of solid 4000 PSI concrete with anchors made of minimum AISI 1018 or 12L14 steel, SAE J 429 Grade 5 fasteners, or other rated fasteners as appropriate for the substrate.

Anchors and fasteners should be spaced not more than 1.22 m (4 feet) on center and should be selected to resist all forces imposed by the fire safety curtain.

The hardware specified in this section is for attaching the Vertical Guide Pockets to the proscenium wall using construction-appropriate anchors and attachments. As wall constructions vary, it is incumbent upon designers and contractors to provide a substrate and attachment hardware suitable to resist the forces imposed by the Fire Safety Curtain as described in the standard.

**A.2.7** Lift lines should be minimum 6 mm (0.25 inch) 7 X 19 small diameter specialty cord (formerly known as galvanized aircraft cable) conforming to ASTM A1023M-09, Standard Specification for Stranded Carbon Steel Wire Rope for Special Purposes.

**A.2.8** Emergency closing speed should be either governed during the curtain's entire travel, or should be decelerated for the last 2.44 m (8 feet) of its travel.

**A.2.8.1** Descent governors should limit the rate of descent of the fire safety curtain during automatic closure.

**A.2.8.2** Deceleration should be accomplished by dashpot, mechanical brake, or other device. Removing weight from the curtain side or adding weight to the counterweight side is not permitted for achieving deceleration.

**A.2.9** Emergency closing of a manual counterweight fire safety curtain system should be one of the following types:

**A.2.9.1** Overbalance Bar System: An overbalance bar system consists of a pipe or bar that is suspended over the fire safety curtain and is guided by the center two or three lift lines. The suspension system for the bar should be designed such that the release line holds the bar suspended over the fire safety curtain and, when emergency closing is activated, the bar's weight is dropped onto the fire safety curtain. The bar should add sufficient weight to achieve emergency closing. Tag lines should be provided on the bar to facilitate the resetting of the bar after it has been tripped. The overbalance bar should be capable of being reset by two people maximum.

**A.2.9.2** Overbalance Arbor System: The overbalance arbor system consists of a guided weight that is released when emergency closing is activated. The weight of the overbalance arbor acts on the fire safety curtain system counterweight so the combined weight of the fire safety curtain and overbalance arbor is sufficient to activate emergency closing. The overbalance arbor should be capable of being reset by two people maximum.

**A.2.10** Emergency closing of a winch operated fire safety curtain system should be by clutch release, brake release, or similar mechanism.

### **A.3 Brail Fire Safety Curtain Systems**

**A.3.1** The minimum clear height to store the brail fire safety curtain should be 1.52 m (5 feet) or 125% of the proscenium height, whichever is greater.

**A.3.2** The top and bottom battens should be as for unframed straight lift wire rope guided fire safety curtain.

**A.3.3** Wire rope guides should be as for unframed straight lift wire guided fire safety curtain. Edge reinforcement should not be used.

**A.3.4** Vertical guide pockets should be as for unframed straight lift, wire rope guided fire safety curtains except the vertical guide pocket should be a minimum of 203 mm (8 inches) in depth measured perpendicular from the proscenium wall with a minimum of 100 mm (4 inches) between the center of the brail curtain and the back of the guide pocket.

**A.3.5** The top batten should be suspended from structural framing.

**A.3.6** Lift lines for brail fire safety curtains should pass through rings or loops on the surface of the curtain. Lift lines should attach to the bottom batten.

**A.3.7** The brail fire safety curtain system should use an electric winch.

**A.3.8** Activation of the emergency closing should release a clutch, brake, or similar mechanism holding the fire safety curtain. Emergency closing speed should be controlled by a governor.

## **Annex B Supplemental Information**

This annex is not a part of the requirements of this standard, and is included for informational purposes only. It contains explanatory material, numbered to correspond with the applicable text paragraphs.

**B.1.2.2** A fire safety curtain system is only one part of an effective life and fire safety plan for a stage in an assembly occupancy. This has been recognized in the US for over 80 years (ref: Letter Circular LC 137, December 13, 1924, US Department of Commerce Bureau of Standards). Current British standards for similar systems also recognize an integrated approach (ref: Technical Standards for Places of Entertainment, Model Technical Regulation, Recommendations E4, District Surveyors Association and ABTT). Contemporary US model fire and building codes have evolved to place greater reliance on fire detection, fire suppression, fire detection and notification systems, smoke management, emergency egress, emergency illumination, type of construction, crowd management, and operations. A fire safety curtain system meeting this standard is most effective if integrated in a coordinated plan. Fire safety curtain systems are limited in effectiveness when used as the sole means of protection. Fire Safety Curtain systems are most effective when efficient extraction ventilation is provided above the stage.

**B.2.7** Other styles or types of fire safety curtains such as trip or roller systems have been constructed and installed. Because of difficulties in reliability, these types are no longer recommended but are permitted to be repaired or replaced subject to specific approval of the authority having jurisdiction.

**B.2.19** Historically, the vertical guide pocket was presumed to contribute to the retardation of smoke movement through the proscenium opening and was called a smoke pocket.

**B.3.1** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**B.3.2.1** The application of ASTM D5034-95(2001) Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test) to glass or other similar brittle-fiber fabrics requires special methods of attaching or gripping the tested fabric to the testing machine, since the standard testing methods will cause premature failure of the fibers at the jaw. Testing of fabrics for compliance with this standard should require modification of the standard testing procedures by the use of either (a) padded jaws, (b) rubber jaws, or (c) gluing of the fabric in a manner such that the fabric failure is not at the jaws and a result of the deformation and distress caused by the jaws but instead tests the fabrics strength.

**B.3.3.1** Exposed cut edges can unravel and should be hemmed.

**B.4.1.1** Fire safety curtain assemblies are intended to provide only a reasonable level of separation of the audience from on-stage fires for a period sufficient for evacuation of the audience. As such, the hose stream test in ASTM E 119-12a should not be required.

**B.4.4.2** It is common place to use knife guides along the sides of the curtain.

**B.4.3.6** Not more than half of all splices in parallel frame members should align in planes perpendicular to the fire safety curtain.

**B.6.10** Guide systems that restrain the edge of the curtain continuously are more likely to overlap the fire safety curtain with the proscenium wall when the fire safety curtain bulges under unequal atmospheric pressures. The natural deflection (hour-glassing) of the common unrestrained wire rope guide system requires limiting the use of this system to fire safety curtain systems for smaller sized proscenium openings where the total pressure is less and the length of the wire rope guide is limited.

**B.11.3** Fire modeling has shown that fusible links do not perform the intended function of releasing the curtain in the event of a fire. See: Fire Safety in Theatres – A New Design Approach by Ove Arup & Partners PC and The Fire Protection Research Foundation <http://www.nfpa.org/research/fire-protection-research-foundation/projects-reports-and-proceedings/building-and-life-safety/general-life-safety-issues/fire-safety-in-theatres-a-new-design-approach>

**B.11.3.1** It is not uncommon for stage effects to include smoke and fog produced intentionally for theatrical effect. In some jurisdictions, the release of the fire safety curtain is required to be interconnected to the building fire detection system. Care in the selection and arrangement of rate-of-rise and/or fixed temperature heat detectors should be exercised to assure that (a) normal stage use of smoke and fog does not activate the emergency release of the fire safety curtain and (b) that a signal from a detector other than in the stage area does not activate the emergency closing release of the fire safety curtain.

**B.11.4.5** The following figure is an example of the sign adjacent to an emergency closing device.

In Case of Fire, Pull Red Ring to  
Lower Fire Safety Curtain

**B.11.10** The limit on velocity for 2.44 m (8 feet) above the floor is intended to prevent or lessen injury to occupants in the path of closing.

**B.11.11** The greater the overbalance of the fire safety curtain the more probable the fire safety curtain will close irrespective of the effects of atmospheric pressure, time, lack of maintenance, and minor obstructions in its path. Speed governors or checking systems more readily permit a greater overbalance of the fire safety curtain and thus generally are more reliable in assuring the fire safety curtain will close in an emergency than overbalance systems that physically add weight to put the curtain out of balance.

The most common governor is a closed loop hydraulic design where a pump is driven by the closing of the fire safety curtain, either connected to the shaft of a winch or to a traction driven head block, and the speed governed by a valve and reservoir. Adjusting the valve permits using the pump as a governor to closing speed.

**B.11.12** Having the fire safety curtain assembly in a closed position has many advantages: first, the fire safety curtain gets moved and used helping to assure that during an emergency the fire safety curtain should perform as expected; second, if there is a problem with the fire safety curtain it will be noticed while being closed or reset; third, it keeps the technicians, janitors, and users conscious of the fact that there is a fire safety curtain and the area below it along with the smoke pockets needs to be kept clear of obstructions; and fourth, it gets the technicians, janitors, and users used to operating the fire safety curtain and through this use they become familiar with the fire safety curtain and its workings and they will become less afraid to use or possibly overlook this piece of safety equipment. If there is a problem closing or resetting the fire safety curtain it will be noticed and maintenance can be performed in a timely fashion.