



ANSI E1.39 – 2015
Entertainment Technology – Selection and Use of Personal
Fall Arrest Systems on Portable Structures Used in the
Entertainment Industry

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

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STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)

1. GENERAL

1.1 Scope.

This standard establishes minimum requirements for the selection and use of personal fall arrest systems (PFAS) on portable structures in the entertainment industry. In addition, the standard establishes minimum requirements for products and portable structures used in the service of PFAS. The requirements for other methods used to protect workers from fall hazards such as safety nets, guard rails, and rope access techniques are not included in this standard. This standard does not preclude the use of other appropriate standards to promote fall protection safety.

***E1.1** Portable structures include some scaffolding, tensile structures, tents, and suspended and supported modular truss structures*

1.2 Purpose.

The purpose of this document is to provide employers and workers methods for protecting workers that meet or exceed current standards for PFAS.

***E1.2** It is the intent of this document to clarify existing standards as an aid to manufacturers, employers and workers in creating a safe work environment in the entertainment industry.*

1.3 Application.

This standard applies to the entertainment industry. It provides PFAS requirements for workers on portable structures in theatre, musical touring, film, trade show and television, or other related industries that use similar portable structures.

1.4 References.

The below listed documents are listed for informational purposes. Only specifically noted sections of these documents will be incorporated into this standard by means of a reference.

ANSI E1.2 - 2013 – Entertainment Technology – Design, Manufacture and Use of Aluminum Trusses and Towers

ANSI A10.32 – 2004 – *Fall Protection*

*Systems- American National Standard for
Construction and Demolition Operations*
ANSI Z359.0 – 2007 – *Definitions and
Nomenclature Used for Fall Protection and
Fall Arrest*
ANSI Z359.1 – 2007 – *Safety Requirements
for Personal Fall Arrest Systems,
Subsystems, and Components*
ANSI Z359.2 – 2007
ANSI Z359.3 – 2007
ANSI Z359.4 – 2007
ANSI Z359.6 – 2009
ANSI Z359.12 – 2009
ANSI Z359.13 – 2009
CFR 1910.27 – *Fixed Ladders*
CFR 1910.28 – *Safety Requirements for
Scaffolding*
CFR 1910.66 – *Appendix C – Personal Fall
Arrest Systems*
CFR 1926.451 – *General Requirements
(Scaffolds)*
CFR 1926.501-503

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STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)

2. DEFINITIONS

2.1 Anchorage, Certified : An anchorage for fall arrest documented by a qualified person to be capable of supporting twice the potential forces that could be encountered during a fall.

2.2 Anchorage, PFAS: The terminating component of a fall protection system that is intended to support any forces applied to the system.

2.3 Anchorage, Intermediate: Additional supports in between the end anchorages on an HLL installation used for the purpose of reducing the total arrest distance or arrest forces at the end anchorages.

2.3 Anchorage Connector: A component or subsystem that functions as an interface between the anchorage and fall protection system, or rescue system for the purpose of coupling the system to the anchorage.

2.4 Deceleration Distance: The difference in height of a user's harness attachment at the onset of the arrest and when the worker comes to a complete stop, minus any elongation of a horizontal or vertical lifeline that occurs during the arrest.

2.5 Free Fall Distance (FFD): The vertical distance traveled during a fall, measured from the onset of travel to the point at which the PFAS begins to arrest the fall.

E2.1 Anchorages used for other purposes such as rescue would require a design factor larger than 2:1.

2.6 Horizontal: The term used to describe the members that connect one top chord to the other or one bottom chord to the other on aluminum truss structures with two top chords, two bottom chords or both. This member is sometimes also referred to as a horizontal spreader.

2.7 Lanyard: A component consisting of a flexible rope, wire rope or strap which typically has a connector at each end for connecting to the body support at one end and to a fall arrester, energy absorber, anchorage connector or anchorage at the other end.

2.8 Lifeline, Horizontal (HLL): A flexible line with connectors or other coupling means at both ends for securing it horizontally between two anchorages or anchorage connectors.

2.9 Lifeline, Vertical (VLL): A vertically suspended flexible line along which a fall arrester travels, with a connector at the upper end for securing it to an anchorage or anchorage connector.

2.10 Live Load: The sum of the static loads of workers and equipment added to the structure.

2.11 Maximum Arrest Force (MAF): The peak force allowed on a user's body during the arrest of a fall.

2.12 Person, Authorized: A person who is assigned by the employer to work in a position that is exposed to a fall hazard

2.13 Person, Competent: A person capable of identifying existing and predictable hazards in the workplace, and authorized to take prompt corrective measures to eliminate the hazards.

E2.12 *The term can apply to users, rescuers or other persons that meet the qualifications of the term.*

E2.13 *See E2.12*

2.14 Person, Designated: A competent person designated by the workers employer to perform a task. **E2.14** See E2.12

2.15 Person, Qualified: 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. **E2.15** See E2.12

2.16 Personal Fall Arrest System (PFAS): A method of fall protection comprised of a full body harness, an anchorage and a means to connect the two, designed to arrest a free fall.

2.17 Rescuer: A person trained in the proper use of available rescue equipment and authorized to perform or assist in the rescue of a fallen user.

2.18 Rollout: An unintended disengagement of a connector caused by pressure on the affected connector's gate from the object to which it is connected.

2.19 Self-Retracting Lanyard (SRL): A device that automatically locks at the onset of a fall to arrest the user, but that moves freely during normal user movement.

2.20 Structure, Portable: An assembled system of reusable structural components specifically designed to be disassembled and moved easily.

2.21 Structure, Supported: An assembled system of structural components that, as a whole, bear on grade and the stability of which is provided primarily by elements acting in compression.

2.22 Structure, Suspended: An assembled system of structural components that, as a whole, is suspended from another existing, portable or supported structural system and the stability of which is provided primarily by elements acting in tension.

2.23 User: A person who performs activities when protected by a personal fall arrest system.

E2.23 *As required by OSHA and current fall protection standards, all users shall be authorized to use a PFAS by the employer, who is also required to train the user prior to the user working at height.*

2.24 Worker: A person who performs specified tasks.

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STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)**3. PORTABLE STRUCTURE REQUIREMENTS****3.1 General Requirements.**

3.1.1 All manufactured components of portable structures shall be designed and fabricated under the supervision of a qualified person.

3.1.2 Portable structures and their components shall be used in accordance with design instructions.

3.1.3 Where personnel access is permitted, the loads caused by a fall arrest shall be accounted for in the design of the structure.

3.1.4 Arresting forces imposed on the portable structure by the maximum possible number of simultaneous falls shall be considered in the design of the structure.

E3.1.4 See ANSI Z359.6-2009, Section 6.3.6 for details of how to account for multiple user falls.

3.1.5 Provisions for PFAS shall be incorporated into the design when; (a) there is reason to believe that workers will access the structure in a fashion that would expose them to a fall hazard requiring the use of PFAS and; (b) the structure will be used where the anchorage of a PFAS to an external anchorage point is infeasible.

3.1.6 Certified PFAS anchorages shall be designed for the simultaneous attachment of one user and one rescuer minimum.

3.1.7 Where rescue plans can be incorporated that do not require rescuer(s) to be on the structure, it is permissible to design the certified anchorages on the structure for one user only.

3.1.8 A qualified person shall provide a drawing detailing the locations of expected equipment loads.

3.1.9 A qualified person shall provide a drawing detailing the maximum number of workers allowed to simultaneously access the structure and any restrictions to this number at any location on the structure.

3.1.10 A drawing shall be provided by a qualified person detailing the location of anchorages on the structure. In addition to the location information, any restrictions to the number of users connected to the anchorage shall be listed.

3.1.11 If the anchorage requires the use of a personal energy absorber or other special equipment, that information shall be detailed on the drawing.

3.2 Suspended Structure Requirements.

3.2.1 All loads shall be analyzed through the suspended structure system components, including any hoist components, to the supporting structure.

3.2.2 The arresting forces shall not cause a suspension member to become unloaded during the arrest.

3.2.3 If the structure is intended for multiple users, the structure shall be designed to limit movement caused by arresting forces.

3.2.4 The structure shall be designed to support all equipment loads plus twice the weight of the maximum number of workers anywhere on the structure.

E3.2.2 *The purpose is to disallow unloading in suspension tension members. As an example, the arresting force shall not cause the unloading of a chain hoist or other suspension components.*

E3.2.4 *Due to the uncertainty involved with loading conditions associated with worker's access to these structures a factor of two shall be applied to the workers weight when determining the adequacy of the structure to support its intended loads.*

3.3 Supported Structure Requirements.

3.3.1 All loads shall be analyzed through the supported structure system components.

E3.3.1 *This would include hoist components in the event hoists are used to lift the structure and remain in place under load.*

3.3.2 Access to a supported structure via climbing the support towers shall require the use of PFAS.

E3.3.2 *Standard support towers do not meet the requirements for fixed ladders. See CFR 1910.27*

3.3.3 The structure shall be designed to support all equipment loads plus twice the weight of the maximum number of workers anywhere on the structure.

E3.3.3 *Due to the uncertainty involved with loading conditions associated with workers access to these structures a factor of two shall be applied to the workers weight when determining the adequacy of the structure to support its intended loads.*

3.4 Supported Scaffold Structure Requirements.

3.4.1 When planning the construction of scaffolding, provision for the use of a PFAS during construction should be made if workers will be more than 3.05 m (10 ft) above a lower surface. The decision of whether or not to use PFAS shall be made by the designated person who is assigned by the scaffold construction entity.

E3.4.1 *The general rule is that if there is an unprotected edge more than 1.83 m (6 ft) [OSHA 1926.501(b)(1)] above a lower surface a worker must be protected, although, while working on scaffolding this height can be increased to 3.05 m (10 ft) [OSHA 1926.451(g)(1)].*

3.4.2 Scaffolds shall be constructed in accordance with the design of a qualified person. Scaffolds shall have a minimum strength sufficient to support the scaffold self-weight plus four times the maximum intended live load.

STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)

4. PFAS REQUIREMENTS

4.1 General.

4.1.1 All PFAS systems, subsystems and components shall meet the requirements of existing ANSI fall protection standards at the time of manufacture. When there is a conflict between standards, the more stringent requirement shall be met.

4.1.2 The PFAS shall protect the user at all times, including when the user is in motion and when transferring from one system to another at height.

4.1.3 The PFAS shall protect the user from striking the floor or other objects in the potential fall path.

4.1.4 When calculating the total arrest distance, any deflection in the structure that would cause an increase in arrest distance shall be included.

4.1.5 The PFAS shall be designed to limit the maximum arrest force (MAF) to 4.0 kN (900 lb) or less when connected to a portable structure.

4.1.6 A PFAS incorporating an energy absorber shall limit the MAF to 4.0 kN (900 lb) or less and limit the deceleration distance to 1.07 m (42 in).

4.2 Anchorage Requirements.

The minimum anchorage ultimate strength shall be 22.2 kN (5,000 lb) per person attached, unless it is certified by a qualified person with a design factor of at least 2:1.

E4.1.1 *In addition to a PFAS, circumstances may require users to wear other forms of personal protective equipment (PPE) such as hand protection, head protection, eye protection, etc.*

E4.1.3 *In many cases a PFAS incorporating a horizontal lifeline (HLL) will not provide adequate protection since most require more than 6.10 m (20.0 ft) of headroom to arrest a fall.*

4.3 Horizontal Lifeline (HLL)

Requirements.

Where the action of a HLL during the arrest of a fall could cause another worker to fall, the number of users in the affected span shall be limited to one.

4.4 Lanyard Requirements.

All lanyards shall be equipped with energy absorbers unless the PFAS limits the free fall to less than 30cm (12 in).

4.5 Rescue Requirements.

4.5.1 When provisions for PFAS are provided on a portable structure, the employer shall provide a written rescue plan.

4.5.2 The rescue plan shall include provisions for rescue during erection or dismantling of the portable structure if these activities require the use of PFAS.

4.5.3 The rescue plan shall provide provisions for access to and retrieval of the fallen user.

4.5.4 The rescue plan shall include methods of rescue, designated rescue personnel, type and location of equipment available for rescue efforts, and effective means to summon rescue personnel.

4.5.5 If the rescue plan is dependent on a designated on-site rescue team, members of the rescue team shall not be engaged in work requiring the use of PFAS, unless after a fall there will be an adequate number of rescuers available to successfully complete the rescue.

E4.5.4 *Prior coordination with emergency personnel would be mandatory to use 911 as the method of retrieval of a fallen user.*

STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)**5. DOCUMENTATION****5.1 General.**

All documentation shall be provided in writing and shall be available at the work site.

5.2 Hazard Analysis.

Prior to selection and installation of PFAS, a Hazard Analysis shall be provided in writing by a competent person and shall identify existing and predictable hazards on the work site.

***E5.2** See ANSI Z359.1-2007, section 7.1 for examples of hazards.*

5.3 Rescue Plan.

The rescue plan shall comply with the provisions of section 4.5

5.4 HLL Limitation.

Where an HLL is used as part of a PFAS, there shall be documentation on site that specifies the following; (a) the minimum anchorage strength requirements, (b) the maximum number of simultaneous users, and (c) the minimum headroom required at the maximum length allowed by the system.

5.5 User Instructions.

When PFAS requires a design by a qualified person, user instructions shall be provided in writing.

5.6 Certified Anchorage Points.

The location and capacity of certified anchorage points shall be available to all users.

STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)**6. PFAS EQUIPMENT SELECTION, INSTALLATION, AND USE****6.1 General.**

6.1.1 All components of a PFAS from the anchorage connector through the full body harness shall meet the requirements of existing ANSI fall protection standards at the time of manufacture.

6.1.2 Where PFAS anchorages are used on portable structures being suspended by hoists, each hoist shall have a rated capacity of at least 8.90kN (2,000lb) or when the hoists are used in a fashion that doubles the capacity, the hoist shall have a rated capacity of at least 4.45kN (1,000lb).

6.1.2.1 In addition to the minimum capacity requirement, no suspension hoist shall be loaded to greater than fifty percent (50%) of its rated capacity while anchorages are being used as part of a PFAS.

6.1.3 All components of a PFAS subjected to an arresting force shall be immediately removed from service and inspected by a competent person prior to any further use. Should any component be found defective during this inspection, it shall be removed from service and replaced prior to further use of the system.

E6.1.3 *As a general rule all portions of a PFAS, with the exception of retractable lifelines, are to be permanently removed from service after being subjected to an arrest force.*

6.1.4 Knots shall only be allowed in a PFAS if the knot is an integral portion of a manufactured product that otherwise meets the requirements of existing fall protection standards. In addition, the knot shall be made permanent through the use of stitching or other methods that prevent the knot from loosening or coming untied.

6.1.5 PFAS equipment shall be installed so that it is protected from coming into contact with hazardous objects or event conditions.

6.1.6 PFAS shall be installed and used in a manner that will stop the user from striking a lower structure during a fall.

6.1.7 All users shall be authorized persons prior to connecting to or otherwise making use of a PFAS.

6.1.8 All designated rescue team members shall be authorized rescuers.

6.1.9 The designated rescue team leader shall be a competent person in rescue techniques

6.2 Anchorage.

6.2.1 Where feasible, PFAS users working on portable structures should select anchorages located on separate permanent structures, unless certified anchorages are located on the portable structure on which the user is working.

E6.1.5 See ANSI Z359.1-2007, section 7.1 for examples of hazards. Event conditions include but are not limited to: Pyrotechnic effects, flame projection, lighting fixtures, and CO₂ foggers.

E6.1.6 Care should be taken in the selection of PFAS components to minimize the hazards associated with striking objects attached to the working surface during the arrest of a fall.

6.2.2 Where certified anchorages are unavailable on portable structures, the employer shall have a qualified person make the determination of whether it is feasible to use the structure as an anchorage. In addition, the competent person shall train the users in the appropriate use and location of the anchorages.

E6.2.2 *The most common anchorage location for HLLs on suspended portable structures, as noted by this task group, is the horizontal (spreader). Preliminary industry testing indicates that the 51 mm, (2 in), O.D., 3.2 mm (.125 in) wall thickness, horizontal spreaders on 521 mm and 762 mm (20.5 and 30 inch), wide trussing conforming to the requirements of ANSI E1.2 may meet the 22.2 kN (5,000 lb), strength required of a non-certified anchorage. However, the arresting force imposed on the spreader also affects the structural integrity of the structure as a whole. It is imperative that a determination be made that the addition of the arresting forces to the structure will not cause a structural failure considering any existing loads on the structure prior to the arresting force being applied.*

6.2.3 Prior to attaching to a certified anchorage, the user shall be informed of the maximum number of simultaneous attachments for which the anchorage was designed.

6.2.4 Anchorage connections shall be stabilized to limit movement. See Figure 01.

6.3 Connector.

6.3.1 Connectors shall be selected and used in a fashion that will minimize the potential for rollout to occur. The size of the connector and the device to which it is connected shall be such that the connector gate cannot be forced open by contact with the device during an arrest.

E6.3.1 *Compliance with this section would eliminate snaphook to snaphook connections in most cases.*

6.3.2 At the time of manufacture, connectors shall be individually proof tested to 16.0 kN (3,600 lb) and marked according to the requirements of the current ANSI Z359 or ANSI A10.32 standard.

6.3.3 Connectors shall have a minimum breaking strength of 22.2 kN (5,000 lb).

6.3.4 Only connectors specifically designed to be used in a choker configuration shall be used in that fashion.

6.3.5 Connectors shall be properly matched to the PFAS system.

6.4 Harness.

All harnesses shall comply with section 6.1 where applicable.

6.5 Horizontal Lifeline.

6.5.1 Where HLLs are used on portable structures the lanyard length shall be such that the maximum free fall distance (FFD) permitted by the system is 1.83 m (6 ft). When a FFD of greater than 1.83 m (6 ft) would result, a shorter lanyard shall be used.

6.5.2 Where self-retracting lanyards (SRL) are used in conjunction with HLLs, the HLL shall be positioned such that the D-ring on the user's harness remains below the HLL.

6.5.3 An HLL anchored to a portable structure shall be designed to require a minimum 22.2 kN (5,000 lb) strength anchorage.

6.5.4 Where an HLL is connected to a portable structure, suspension component or hoist, all anchorage points shall be braced to limit horizontal movement due to a fall arrest force acting on the end or intermediate anchorage.

E6.5.1 *Though 1.83m (6 ft) lanyards are very common, they may not be appropriate for this use since a free fall of greater than 1.83m (6 ft) will occur when the user's harness D-ring is above the height of the horizontal lifeline.*

E6.5.2 *Where feasible, strong consideration should be given to using a SRL in conjunction with a HLL as the FFD will be minimized when compared to using standard lanyards.*

6.5.4.1 Where an HLL is connected between the hoist and roundslings, the angle of the bracing shall be 45 degrees or less from horizontal. (See Figure 01)

E6.5.4.1 *Although, to stabilize the anchorage, a small angle is desirable, it also increases the force on the slings and the structure. For this reason, angles of less than 30 degrees should be avoided.*

6.6 Lanyard.

6.6.1 Prior to using an HLL/lanyard combination that could result in a FFD of greater than 1.83m (6 ft), the user shall be instructed on how to use the combination in a fashion to prevent a FFD of greater than 1.83m (6 ft). This instruction shall be both verbal and written.

6.6.2 The snaphook on a lanyard shall not be connected to the snaphook on an SRL.

E6.6.2 *Generally snaphook to snaphook connections are incompatible. In addition, connecting a lanyard to an SRL can introduce increased FFD for which the SRL is not designed.*

6.7 Self-Retracting Lanyard.

6.7.1 SRLs shall be mounted at a height such that it is impossible for the lifeline to reach full retraction with the user working at the highest work level.

E6.7.1 *Where headroom allows, the device should be suspended at least 3.05 m (10 ft) above the highest working surface on which the user could be standing while being connected to the SRL.*

6.7.2 An SRL anchored to a portable structure shall require a minimum 22.2 kN (5,000 lb) strength anchorage.

6.8 User Owned Equipment.

6.8.1 User-owned harnesses, lanyards, and connectors are permitted, if approved for use by an employer designated competent person at the work site. However, the controlling employer has the right to refuse to allow the use of user-owned equipment.

E6.8.1 *It is important for a competent person to evaluate the user-owned equipment in relation to its compatibility with the rest of the PFAS to which it is being attached.*

6.8.2 User-owned equipment shall comply with the inspection requirements listed in *Section 8*.

6.9 Vertical Lifeline.

6.9.1 Only the specific lines approved by the fall arrester manufacturer shall be used as vertical lifelines (VLL).

E6.9.1 *This section does not preclude purchasing lifelines separately from fall arrest devices, however, it does require checking with the manufacturer or the literature provided with the device to insure that the line proposed for use is approved.*

6.9.2 Prior to use, a competent person shall ensure an approved line is used in conjunction with the fall arrest device.

6.9.3 If a lanyard is used to connect the harness to the fall arrest device, the maximum lanyard length shall be 0.91m (3 ft).

6.9.4 A VLL anchored to a portable structure shall require a minimum 22.2 kN (5,000 lb) strength anchorage.

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7. TRAINING

7.1 PFAS Users.

Users shall be trained in the proper use, inspection, and limitations of the particular system, subsystems, and components to which they are attaching. This training shall take place prior to using the PFAS.

7.2 Rescuers.

Authorized rescuers shall be trained in the proper use of available rescue equipment and shall also be trained in the effective retrieval of a fallen user without inflicting additional injuries to the fallen user.

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STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)**8. INSPECTIONS**

8.1 Inspection procedures shall be performed by a competent person.

8.2 Inspection procedures shall be performed on all fall protection equipment in use, or scheduled for use, including PFAS, portable structures and hoists.

8.3 Inspected equipment found to be damaged or unsafe shall be removed from service immediately and clearly marked as damaged until repaired or destroyed.

8.4 All repairs made to damaged PFAS equipment shall be performed by the manufacturer or a qualified manufacturer's representative.

8.5 PFAS equipment shall be inspected by the user before each use.

8.6 PFAS equipment shall be inspected by a competent person other than the user at least once a year, unless the manufacture requires more frequent inspection intervals.

8.6.1 During the above inspection the competent person shall make the determination that the PFAS meets or exceeds the requirements of fall protection regulations in effect at the time of inspection. Any component not meeting current regulations shall be removed and replaced with a component that does meet current regulations.

E8.2 *While portable structures and hoists can be components of a fall protection system, their inspection and repair procedures may differ from those listed in this section. See ANSI E1.2-2013 for aluminum structures inspection guidelines.*

E8.5 *See ANSI Z359.1-2007, Section 6.1 for further details.*

E8.6 *See ANSI Z359.1-2007, Section 6.1 for further details.*

8.7 Equipment shall be removed from service if any of the following conditions are discovered during inspection:

- absent or illegible labels;
- absence of components causing an impairment of function, or otherwise reducing system safety or strength;
- defects in or damage to components causing an impairment of function, or otherwise reducing system safety or strength;
- alteration of components causing an impairment of function, or otherwise reducing system safety or strength;
- fading or discoloration of webbing material;
- evidence of wear on wear-mark indicators provided by the manufacturer at attachment points.

E8.7 *For further clarification see ANSI Z359.1-2007*

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STANDARD REQUIREMENTS

EXPLANATORY INFORMATION
(Not requirements of E1.39)**9. STORAGE**

PFAS equipment shall be properly stored after each use in accordance with manufacturer's written instruction. Proper storage may include but is not limited to the following conditions:

- in the carrying bag provided with the harness or other durable carrying bag;
- away from sharp objects, tools or hardware that may cut or fray the materials;
- out of direct sunlight;
- away from solvents, acids, or corrosive substances;
- in a dry, dark place that is free of contaminants;
- away from extreme heat or extreme cold.

Prior to storage, any moist PFAS equipment shall be air dried.

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10. FIGURES

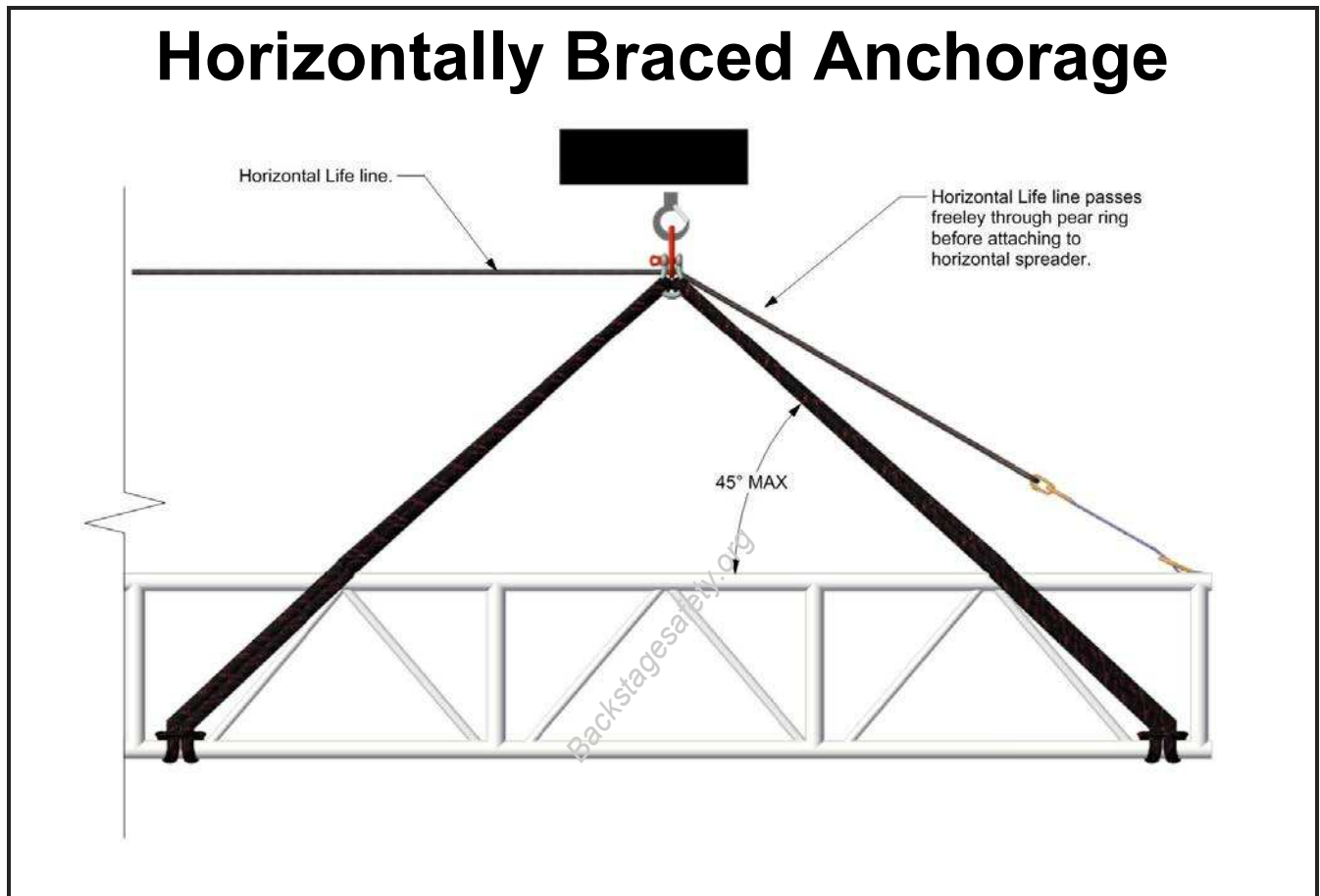


Figure 01