Technical Advice

Fall Protection in Bridge Construction, Inspection, and Maintenance

March 2016

Work Zone Safety Consortium

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Preface

The U.S. Department of Transportation, Federal Highway Administration (FHWA) has jurisdiction for roadway bridges and the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) has regulatory authority for safety practices in bridge construction, inspection, maintenance, and repair.

According to the FHWA report Safety and Health on Bridge Repair, Renovation and Demolition Projects (Publication Number: FHWA-RD-98-180) Chapter 3, Section 2: Fall Protection, “To protect employees when they are exposed to fall hazards, some form of fall protection must be used. The most common forms of fall protection are guardrails, personal fall arrest systems, hole covers, and safety nets. Any one or all of these forms of fall protection may be used on construction worksites. The current OSHA standards also require that employees receive training regarding fall protection issues, and that the training is documented.”

This document provides technical advice on fall protection requirements, fall protection systems selection, fall protection plans, employee training, training documentation, and fall rescue plans.

Objectives

This document contains a series of fact sheets on key issues in the selection and use of fall protection in bridge construction, inspection, and maintenance. This document contains the following fact sheets:

• Fall Protection Systems for Bridge Work
• Fall Protection for Bridge Contractors in 4 Main Steps
• Guide to Selecting Fall Protection Systems for Bridge Work
• OSHA Fall Protection Standards Bridge Contractors Must Know
• Selecting PFAS Lanyards and Connectors for Bridge Work
• Advantages of Self Retracting Lifelines for Bridge Work
• Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance
• Preventing Swing Falls in Bridge Work
• Preventing Suspension Trauma
• Fall Arrest Suspension Trauma Medical Emergency Wallet Card
• Sample Fall Rescue Plan for Bridge Work
• Employee Fall Protection Training Record
• Sample Fall Protection Plan for Bridge Work

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Occupational Safety and Health Administration (OSHA) fall protection regulations provide detailed definitions of conventional fall protection systems. The OSHA regulations apply to any work 6 feet or more above levels to which workers could fall. The OSHA fall protection standards appear in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards. The ARTBA position is that use of conventional fall protection equipment is feasible in bridge work.*

**What Is Fall Protection?**

Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. Two basic categories of conventional fall protection equipment systems are available for bridge contractors:

- **Fall prevention systems** that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- **Fall arrest systems** that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

**Fall Prevention Systems**

**Guardrails** are vertical barriers erected to prevent workers falling to a lower level. Guardrails are an engineering control. Guardrails may be cable, metal, plastic, or wood. Guardrail systems for fall protection are usually different from highway guardrails designed to keep vehicles on the road. Guardrails in place on bridges may not meet OSHA requirements.

(a) Existing bridge guardrails may not meet OSHA requirements. This guardrail is too short and lacks toeboards. Photo source: NBC. (b) This existing guardrail appears to meet OSHA requirements. Photo source: BravoFence. (c) When existing guardrails are not adequate or are not in place, then temporary guardrail can be installed. Photo source: J-Safe.

A standard guardrail consists of a top rail, midrail, toeboard, and uprights. The toeboards prevent tools and materials falling off the work area. The top rail must be 39 to 45 inches above the working surface and must withstand at least 200 pounds of force without deflecting to a point less than 39 inches above the working surface. The midrail must be midway between the top rail and the working surface and must withstand 150 pounds of force. The toeboards must be a minimum of 3.5 inches high and withstand 50 pounds of force. Guardrails may include mesh or wire as greater protection from falling objects.

Guardrail systems provide many advantages. Chief among these is that guardrails are a passive fall prevention system, so workers are not required to operate the equipment after it is installed, though regular inspections by a competent person are necessary. In general, guardrails are the preferred fall protection system when feasible.

*Note: This fact sheet covers conventional fall protection as defined by OSHA. 29 CFR 1926.501(b)(2)(i) requires use of guardrail systems, safety nets, or personal fall arrest systems for employees doing leading edge work. Controlled Access Zones (CAZ) are not presented here because CAZ is not conventional fall protection. A CAZ can be used only if a bridge contractor can demonstrate that use of conventional fall protection is infeasible or creates a greater hazard.
Personal Fall Restraint Systems (PFRS) **prevent** users falling *any* distance. A PFRS acts as a leash and keeps a worker’s center of gravity from reaching a fall hazard. Like a personal fall arrest system (PFAS), a PFRS includes anchorage, a body harness, connectors, and a lanyard or lifeline. PFRS anchor strength requirements are less than PFAS but, due to the likelihood of misuse or mishap, comparable strength is recommended by experts. A PFRS is more difficult to set up and use than is a PFAS. Like PFAS, PFRS is *active* fall protection because workers must operate it.

**Photo source: OSHA.**

**Fall Arrest Systems**

Safety nets are hung beneath or around work areas to catch workers or debris. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Safety nets have three main parts and three optional parts:

- **net mesh**
- **support cables**
- **mounting brackets**
- **outriggers**
- **cantilever arms**
- **various adapters**

Safety nets are classified as fall *arrest* because nets catch workers *after* a fall. Nets do not prevent falling. Unlike PFAS, safety nets do not require workers to actively do anything to make nets work. Therefore, safety nets are called *passive* fall protection systems.

**Personal fall arrest systems (PFAS)** are designed to catch a worker who has fallen. It must hold the fallen worker safely until rescue. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. A PFAS must limit maximum arresting force to 1,800 pounds. The free fall distance cannot exceed 6 feet. PFAS is an *active* fall protection because workers must operate it. Thinking of the PFAS parts as A-B-C-D helps users remember how the system works and the importance of each part in the system. Here are the A-B-C-Ds of PFAS:

**A. Anchor** is a secure point at which to attach a lifeline, lanyard, deceleration device, and/or rescue equipment. The best body harness, lanyard, and connectors are nothing without proper anchorage. Anchorage must be capable of supporting at least 5,000 pounds per worker.

**B. Body harness** consists of shoulder straps, shoulder strap retainer, D-ring, waist strap, thigh straps, sub-pelvic support, and adjustment buckles. The straps distribute fall arrest forces over the upper thighs, pelvis, chest, and shoulders. The D-ring (attachment point) is typically located between the shoulder blades.

**C. Connectors** are usually D-rings, carabiners, and/or locking snaphooks. (See the ARTBA fact sheet *Selecting PFAS Lanyards and Connectors for Bridge Work.*)

**D. Descent and rescue** devices are used to retrieve or lower a fallen worker. These devices and the techniques/skills to use them are an essential part of the fall protection program. (See the ARTBA fact sheets *Preventing Suspension Trauma* and *Sample Fall Rescue Plan.*)

**Positioning devices** are body belt or body harness systems rigged to allow a worker to be supported on an elevated *vertical* surface, such as a wall. In construction work, a positioning device may be used only to protect a worker on a vertical work surface. These devices may permit a fall of up to 2 feet, but positioning devices are not designed as fall arrest. Examples of use include concrete form work or installation of reinforcing steel.

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- International Union of Operating Engineers
- Community College Consortium For Health and Safety Training
- U.S. Department of Transportation Federal Highway Administration
- Texas A&M Transportation Institute
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Fall Protection for Bridge Contractors in 4 Main Steps

For the third year in a row, fall protection was #1 on the Occupational Safety and Health Administration (OSHA) Top 10 list of the most cited violations, with 8,241 fall protection citations issued in 2014, according to OSHA. Now, more than ever, all bridge contractors must learn how to implement comprehensive fall protection programs.

Bridge contractors can achieve 100% fall protection by taking four key steps:
- plan
- provide
- train
- enforce/evaluate

Leading Cause of Death

Falls are the leading cause of death in construction. Falls took the lives of 699 construction workers in 2013 alone. The majority of these fatal falls (82%) were falls to a lower level. Of the lower level falls, about 25% were from 10 feet or less while 75% were from heights of 11 feet and higher (with 55% falling between 11-29 feet and 20% falling 30 feet or more).

The following fatalities illustrate the risks for workers on bridges throughout the United States.
- A 45-year old bridge worker fell 70 feet to his death from the Mount Hope Bridge in Connecticut.
- Two bridge workers, ages 53 and 63, fell 90 feet to their deaths from a bridge near Montgomery, Alabama.
- A 34-year old bridge worker fell 60 feet to his death from a bridge across Lake Washington near Seattle.

When bridge contractors implement effective fall protection programs, they increase worker safety and help prevent deaths and permanent injuries. OSHA, in partnership with the National Institute for Occupational Safety and Health (NIOSH) and National Occupational Research Agenda (NORA) – Construction Sector, has been waging a nationwide outreach campaign to raise awareness among workers and employers about common fall hazards in construction.

The campaign focuses on how falls from ladders, scaffolds, bridge structures, and bridge decks can be prevented. Lives can be saved through an important and highly effective 4-step process: plan, provide, train, and enforce/evaluate.

Step 1: Plan

A well-designed fall protection plan written by a qualified person is the first step to reducing risks and saving lives. OSHA mandates that the fall protection plan must be developed by a qualified person with relevant knowledge and training in order to successfully implement an appropriate fall protection program.

A comprehensive bridge fall protection plan developed by a qualified person should include a statement of company

policy signed by the highest level of management. The company policy must clearly state employee and supervisor responsibilities as well as enforcement measures and appropriate disciplinary actions. The bridge fall protection plan must also be site specific, with a detailed list of fall prevention measures.

The bridge contractor should designate the competent person(s) in writing. The competent person(s) must:

- Be responsible for implementing the fall protection plan
- Have absolute authority over the fall protection plan
- Have unquestioned authority to stop work and correct fall hazards
- Oversee documented inspections where fall protection measures are utilized
- Keep fall protection equipment maintenance records, records of prompt removal of defective equipment, incident reports, accident investigations records, and employee training records
- Prepare to train employees by acquiring or developing a training program

The fall protection plan must include performing a thorough **hazard analysis** to determine the areas of risk and methods of engineering out the hazards, if possible. (A **Sample Fall Protection Plan for Bridge Work** is available from ARTBA.) Selection of fall protection systems should be made at this stage. Contingency plans and appropriate rescue equipment should be selected. Finally, a method for enforcing the plan and evaluating effectiveness should be developed.

ARTBA’s Fact Sheet **Guide to Selecting Fall Protection Systems for Bridge Work** provides detailed descriptions of fall protection equipment and a flow chart to aid selection of fall protection in bridge work.

**Step 2: Provide**

To protect employees working at 6 feet or higher above lower levels, employers must **provide** the correct fall protection equipment for the job. To help prevent falls, employers must also **provide** the correct types of ladders, scaffolds, and safety gear.

All fall protection systems and scaffold systems must be designed and/or installed under the supervision of a **qualified person**. OSHA defines a qualified person as one who “… has proven knowledge, skills, experience, education, certification, or professional standing to solve or resolve problems related to the subject matter, the work, or the project.” [29 CFR 1926.32(m)]

**Step 3: Train**

At a minimum, each employee who might be exposed to fall hazards must be trained by a **competent person** who is qualified in the following areas [29 CFR 1926.503(a)(2)]:

- The nature of fall hazards in the work area
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems
- The use and operation of guardrail systems, personal fall arrest systems, safety net systems, and/or other protections
- The OSHA fall protection standard

ARTBA offers training products and informational documents, including an **Employee Fall Protection Training Record**, to help bridge contractors deliver and document required fall protection training for employees.

**Step 4: Enforce/Evaluate**

The company fall protection program must contain mechanisms for enforcing requirements and evaluating the effectiveness of the program. Enforcement mechanisms can include discipline within the normal chain of command, for example. Evaluation can include comparison reviews of training records and policy infractions as well as analysis of any accidents that might occur.

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Bridge work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, and other activities.

Occupational Safety and Health Administration (OSHA) fall protection regulations apply to any work 6 feet or more above levels to which workers could fall. OSHA fall protection standards are in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards.

**Fall Hazard Analysis**

OSHA requires bridge contractors to assess all the hazards of each job before work begins. One method for doing this is a *Job Hazard Analysis*. A Job Hazard Analysis is a systematic method for determining what specific hazards exist or may arise during work and what appropriate actions need to be taken to protect workers. In bridge work, the number one hazard is falls. Therefore, an analysis of fall hazards is essential. The contractor may do this or the contractor may assign the competent person for fall protection to complete the analysis.

Following the hazard analysis, a site-specific fall protection plan should be developed. (A *Sample Fall Protection Plan for Bridge Work* is available from ARTBA.) The written plan tells how to control each fall hazard. It should list the conventional fall protection measures to be used, how they are to be used, and who is responsible for supervision and training. At this point, the selection of appropriate and effective fall protection systems is a critical activity.

During this process, the contractor and/or the competent person will refer to the hierarchy of hazard controls to assess how the fall hazards will be addressed. In descending order, the hierarchy is:

- substitution (rarely applicable in construction)
- engineering controls, such as guardrail systems
- administrative procedures, such as restricted entry to controlled access zones
- personal protective equipment (PPE), such as a personal fall arrest system (PFAS)

Some fall protection systems are engineering controls. Some are PPE. Some are a combination.

**What Is Fall Protection?**

Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. (See ARTBA’s *Fall Protection Systems for Bridge Work.*) Two basic categories of fall protection systems are available for bridge contractors:

- Fall prevention systems that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- Fall arrest systems that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

**Fall Protection Flow Chart for Bridge Work**

The *Fall Protection Flow Chart For Bridge Work* on the reverse is a decision tool for analyzing fall hazards and fall protection needs for a bridge jobsite. Answering the questions in the chart can aid in the selection of fall protection systems.
### Fall Protection Flow Chart for Bridge Work

**Fall Protection Flow Chart**

1. **Eliminate Fall Hazard**
   - Can the Fall Hazard Be Eliminated? [YES]
   - NO: Go to 2. Prevent

2. **Prevent Fall Hazard**
   - Is Equipment Inspected? [NO]
     - NO: Go to 3. Arrest
   - YES: Go to 3. Arrest

3. **Arrest Fall Hazard**
   - Is Guarding Feasible? [YES]
     - NO: Go to 4. Arrest
   - YES: Apply Guarding
   - Are Fall Arrests or Nets Feasible? [NO]
     - NO: Go to 5. Arrest
   - YES: Apply Fall Arrest
   - Are Control Lines Feasible? [NO]
     - NO: Go to 5. Arrest
   - YES: Apply Control Lines

4. **Control Fall Hazard**
   - Is the Fall Hazard Be Eliminated? [NO]
     - NO: Investigate Special Circumstances
   - YES: Apply Fall Protection

5. **Conclusion**
   - Does a Fall Exposure Exist? [YES]
     - NO: Go to 6. Prevent
   - YES: Investigate Special Fall Hazards
   - Does a Fall Exposure Exist? [NO]
     - NO: Fall Protection Required

**Safety Hierarchy**

1. Eliminate
2. Prevent
3. Arrest

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**Fall Protection (continued)**

- Can You Think of Other Examples? (For example: OSHA 1926.21(b)(2); 1926.500(g)(6)(i) and (ii)(a) through (f) and (iii); 1926.503(a)(1) and (2)(i) through (vii); ANSI Z359.2)

- Can You Add: 1) Fall Restraint 2) Fall Arrest 3) Control Lines

- Does a Fall Exposure Exist? [YES]
  - NO: Investigate Special Fall Hazards

- Does a Fall Exposure Exist? [NO]
  - NO: Fall Protection Required

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**Develop Fall Protection Plan**

- For Pre-Job Duty (Duty of Employer, Estimator, Safety Officer, Competent Person)

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**Pre-job Estimator and Foreman/Competent Person**
No single standard of the Occupational Safety and Health Administration (OSHA) covers all the fall protection requirements a bridge contractor needs to know. A bridge contractor must be familiar with at least four subparts of OSHA standards. Further, OSHA standards are minimum standards, so knowledge of several standards of the American National Standards Institute (ANSI) covering fall protection is often also required. The table below provides a general overview of the relevant OSHA standards.

**OSHA Fall Protection Standards for Bridge Contractors (29 CFR 1926)**

<table>
<thead>
<tr>
<th>OSHA Subpart</th>
<th>Situation</th>
<th>Requirements</th>
<th>OSHA Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subpart E</strong></td>
<td><strong>Personal Floatation Device (PFD)</strong></td>
<td><em>Working over water where there is a hazard of drowning</em></td>
<td>1926.106(a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Where a personal fall arrest system (PFAS) is used 100% of the time and no drowning hazard</em></td>
<td>1926.106(a)</td>
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<tr>
<td></td>
<td></td>
<td><em>Where safety nets are used for fall protection</em></td>
<td>1926.106(a)</td>
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<tr>
<td><strong>Subpart L</strong></td>
<td><strong>Scaffold Fall Protection Requirements</strong></td>
<td>Scaffolding</td>
<td>1926.451(g)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suspended scaffolding of any type</td>
<td>1926.451(g)(1)(i)&amp;(ii)</td>
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<tr>
<td></td>
<td></td>
<td>Aerial lifts - NOTE: personal fall protection must satisfy criteria in 1926.502(d) &amp; (e)</td>
<td>1926.453(b)(2)(v)</td>
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<tr>
<td><strong>Subpart M</strong></td>
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<td><strong>Leading edges on bridge decks</strong></td>
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<td></td>
<td>Bridge decks, unprotected sides and edges</td>
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<td></td>
<td>Holes/floor (bridge deck) openings 2&quot; and greater</td>
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<td>Formwork and reinforcing steel</td>
<td>1926.501(b)(5)</td>
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<td>Ramps, walkways, and runways</td>
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<td>Working above dangerous equipment</td>
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<td><strong>Precast concrete erection</strong></td>
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<td><strong>Concrete &amp; Masonry Requirements</strong></td>
<td>Impalement hazard (must be guarded)</td>
<td>1926.701(b)(1)</td>
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<td></td>
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<td>Any exposure</td>
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<tr>
<td><strong>Subpart R</strong></td>
<td><strong>Steel Erection</strong></td>
<td><strong>General Requirements</strong></td>
<td>1926.760(a)(1)</td>
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<td>Connectors</td>
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<td>Fall Protection Systems</td>
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<td>Perimeter Safety Cables</td>
<td>Varies</td>
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<td></td>
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<td>See App. G</td>
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*Working over water see [WWW.OSHA.GOV](https://www.osha.gov) for letter of interpretation dated September 28, 1999 linked to 1926.106(a).

**Leading edge work requires conventional fall protection, unless the employer can demonstrate it is not feasible. Where the employer determines it is not feasible, a site-specific written plan in accordance with 1926.502(k) must be developed, implemented, and supervised by a competent person.**

***See OSHA’s [WWW.OSHA.GOV](https://www.osha.gov) eTool and Directive CPL 02 01 034 for more detailed information and NIOSH Campaign to Prevent Falls in Construction [WWW.CDC.GOV/NIOSH/](https://www.cdc.gov/niosh/).***

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In a personal fall arrest system (PFAS), a lanyard connects a body harness to an anchor or to a horizontal or vertical lifeline. Lanyards are typically made from 3-foot to 6-foot lengths of synthetic webbing or rope, or wire rope, with attached connectors such as snap hooks, carabiners, or other devices. Lanyards may have built-in shock absorbers to reduce the impact of a fall.

Ideally, a personal fall arrest system is designed, tested, and supplied as a complete system. However, it is common practice for PFAS components to be interchanged because some parts wear out more quickly. The employer should realize that not all components are interchangeable. Proper selection of compatible PFAS components is discussed on the reverse.

### Lanyard Length and Total Fall Clearance Distance

Selection of lanyards in bridge work must consider the **total fall clearance distance** of a potential fall. The total fall clearance distance is the vertical distance from the anchor to the nearest lower obstruction that a falling worker would impact, such as a structural member or the ground. Five basic factors make up this distance:

1. **lanyard length**
2. **deceleration distance** of the energy absorber in a shock-absorbing lanyard or a shock-pack lanyard
3. **estimated materials stretch**
4. **estimated D-ring movement**
5. **height of the suspended worker**

The illustration at left shows how these factors affect total fall clearance distance for a 6-foot worker using a 6-foot lanyard anchored overhead. Safely arresting the fall of a 6-foot worker using a 6-foot lanyard requires approximately 17.5 feet of clearance from the anchorage point to the nearest lower obstruction.

In cases where vertical lifelines or horizontal lifelines are used, calculations of total fall clearance distances must also include the slip of the rope grab plus lifeline stretch (vertical lifeline) or the displacement plus stretch of the lifeline (horizontal lifeline).

For anchorage below standing D-ring level, careful calculation and a larger shock-pack are required to control arresting force.

The required total fall clearance distance may be shortened in any setup by using a shorter lanyard (3, 4 and 5-foot lengths) or by using a self-retracting lifeline (SRL).

When selecting a lanyard for use in an aerial work platform (AWP), consult the operator’s manual to determine the recommended lanyard length. It is best to use a lanyard that will restrain the worker on the AWP and will not allow the worker to fall or be catapulted over a guardrail.

### Lanyard Length and Fall Force

Always select the shortest possible lanyard. The longer the lanyard, the longer the fall and the greater the fall forces. Even short falls can generate huge amounts of force. A 200-pound worker falling 10 feet is subject to 8,000 pounds of force on abrupt impact. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. Lanyards must be selected to limit free falls to no more than 6 feet and 1,800 pounds of force \([\text{CFR 1926.502(d)(16)(ii)}]\).
Lanyard Specifications
Lanyards must display approval by the American National Standards Institute (ANSI) or the American National Standards Institute/American Society of Safety Engineer’s (ANSI/ASSE). Lanyards meeting the specifications of ANSI A10.32, ANSI/ASSE Z359.1 or ANSI/ASSE Z359.13 are permitted in the construction industry. ANSI/ASSE Z359.1 and Z359.13 are more stringent and more comprehensive than the ANSI A10.32.

Compatibility of Lanyards and Connectors
Connectors on lanyards – such as snap hooks, carabiners, scaffold hooks, or web loops – should be appropriate for the connection made. While a web loop may be appropriate for wrapping around a beam, a snap hook is more often used to connect to a vertical or horizontal lifeline. Scaffold hooks, due the larger opening, are often a better choice for anchors of convenience, such as rebar. When connecting directly to a lifeline, the connector may be an ascender/descender device.

PFAS components are often not interchangeable, whether from one manufacturer or not. In 29 CFR 1926 Subpart M Appendix C, OSHA reminds employers that they must evaluate the compatibility of all components before they are used to protect employees. Manufacturers issue numerous technical bulletins and educational pamphlets to aid in this evaluation.

In particular, OSHA requires employers to determine whether snaphooks are compatible with the members to which they are connected [29 CFR 1926.502(d)(5) and 1926.502(d)(6)(v)].

Connector Specifications
OSHA, ANSI A10.32 and ANSI/ASSE Z359.1 all require that snaphooks and carabiners be self-closing and self-locking. Opening and releasing snap hooks requires two consecutive deliberate actions to prevent rollout and other accidental openings of the snap hook or carabiner. Both ANSI standards are compliant with OSHA 29 CFR 1926.502 requirements.

All acceptable snap hooks or carabiners have a kilo-Newton (kN) rating engraved into the spine. Since 2007, the newest ANSI standard requires all fall protection hardware to have a minimum 16 kN (3,600 pounds) rating for the gate and 22.5 kN, (5,000 pounds) tensile load (ANSI Z359.1-2007, Section 3.2.1.4.). (A kilo-Newton equals about 225 pounds, which is a force of gravity and not static weight or mass. Force = mass times acceleration.)

Compliant connectors are clearly stamped with strength ratings. Avoid any connectors not so marked. Dealing with reputable manufacturers and distributors helps assure acquisition of compliant connectors.

In addition to kN and/or pounds ratings, the stamp should include: year of manufacture and ID, part number, load rating for major axis, load rating for gate and – for non-integral connectors – the ANSI Z359.1(07). Although OSHA stopped requiring the construction industry to meet ANSI 2007 in 2010, it is industry best practice to follow this standard.

Inspection of Lanyards and Connectors
Personal fall arrest system components must be inspected by the user prior to each use and by a competent person on a regular schedule. Defective components must be removed from service [OSHA 29 CFR 1926.502(d)(21)].
Advantages of Self Retracting Lifelines for Bridge Work

A self-retracting lifeline (SRL) is a deceleration device. The SRL contains a drum-wound line that may be either slowly extracted from or retracted onto the drum under slight tension during normal worker movement. A fall automatically locks the drum and arrests the fall. In some cases, despite higher costs, the SRL provides distinct advantages over a lanyard or lifeline and lanyard combination:

- **Reduced free fall compared with lanyard or lanyard-lifeline.** SRLs require less than two feet to arrest a free fall if the anchorage point is vertically above the worker versus 17.5 feet from an anchorage point for a shock-absorbing lanyard.

- **Reduced risk of impacting ground or other objects during a fall.** SRLs provide lower risk of hitting the ground or any other object at a lower level compared with the greater risk due to longer fall distance with a standard lanyard.

- **Easier rescue.** SRLs provide safer and easier rescue of a fallen worker compared with a standard lanyard. With an SRL, the fallen worker may self-rescue using a self-rescue pulley system attached near the SRL anchorage point. Some SRLs have built-in raise or lower options allowing coworkers to perform rescue with little risk. This must be part of the Rescue Plan. (A Sample Fall Rescue Plan is available from ARTBA.)

- **Reduced chance of tangles and trips while working.** SRLs reduce the chances of getting tangled and tripping compared with a standard anyard or lanyard and lifeline because the SRL retracts automatically.

**Limitations**

The horizontal distance for work from the anchor point with an SRL is limited, as it is with a lanyard and standard lifeline. The chart below shows safe maximum horizontal working distances for an SRL. Exceeding the distance shown in the chart may result in a hazardous pendulum swing. (Preventing Swing Falls is available from ARTBA.)

**Examples**

Horizontally, the distance a worker in an SRL can move from the anchor point is limited – as it is with a lanyard and standard lifeline. Evaluate the examples below to see how the chart works.

1. If a worker would like to be able to work 20 feet from the anchor point of the SRL, how high above must the anchor point be placed?
   - Look across the chart horizontally on the horizontal working distance axis to the 20-foot mark. This is the desired horizontal working distance from the anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring on the left (H). In the example to permit 20 feet of horizontal movement, the anchor would have to be at 50 feet above D-Ring height.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will be permitted?
   - In this case find the the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow that point down to the axis for horizontal working distance from anchor point (D). The answer is about 15 feet working distance.

Not all SRLs are created equal! Some use wire rope; others use webbing. The choice is frequently based on the work performed. Some SRLs are small and lightweight, good for light duty jobs or where work takes place near the anchor location. Others are heavier for long-term work and may have retractable lines up to 100 feet or more in length. Some can switch between fall restraint or fall arrest modes, and some have built-in automatic rescue options, which are more protective and expensive. Some SRLs are designed for leading edge work where a wire rope or web can pass over a sharp angle or edge, or when workers must anchor near their feet. In every case workers must know the limitations of their SRLs. Several of the important SRL selection and use considerations appear on page 2.
Important SLR Selection and Use Considerations

In bridgework SRLs may be used for leading edge work or where anchorage ends up near the worker’s feet. These circumstances result in additional hazards addressed only by SRLs rated for leading edge work. These hazards, listed below, have resulted in the American National Standards Institute (ANSI) August 2012 Standard Z359.14 on Self Retracting Devices (SRDs).

- **Increased Fall Distance**: When workers are attached at foot level, as they often are in leading edge applications, they will fall farther than they would if they were anchored at shoulder height or above. The required clearance when anchored at foot level varies by product. Therefore, contractors must follow the manufacturer’s instructions.

- **Lock-Up Speed**: Self-retracting lifelines react to a fall when the line accelerates out of the housing at a certain velocity, generally about 4.5 feet per second. When self-retracting lifelines are anchored at foot level, the lifeline does not achieve the required acceleration during a fall until after the user’s D-ring passes over the leading edge and below the level of the anchor. This means the user has already fallen about 5 feet before the self-retracting lifeline device will engage to arrest the fall.

- **Increased Fall Arrest Forces**: Falling farther means the impact on the body through the fall protection system will potentially be higher when the fall is arrested. This is why many leading edge and sharp edge rated products contain additional energy-absorbing devices.

- **Increased Potential for Swing Hazards**: Depending on a worker’s position when a falls begins, the worker may swing like a pendulum after the fall is arrested. While swinging is a hazard under any circumstances, the danger is compounded if the worker’s lifeline is strung taught over a sharp edge and saws back and forth. (See ARTBA’s *Preventing Swing Falls in Bridge Work*.)

Failure to use an SLR rated for leading edge work may result in excess fall forces applied to the worker’s body or to the wire rope or webbing being severed by the edge over which the fall has occurred resulting in serious injury or death.

**Further Considerations**


1. ...Consideration should be given to the particular work environment. For example, the presence of acids, dirt, moisture, oil, grease, etc., and their effect on the system, should be evaluated. Hot or cold environments may also have an adverse effect on the system. Wire rope should not be used where an electrical hazard is anticipated. ... 

2. Where lanyards, connectors, and lifelines are subject to damage by work operations such as welding, chemical cleaning, and sandblasting, the component should be protected, or other securing systems should be used. ...

For example, if hot work of some kind – welding, torch-cutting, or burning – is performed, SRLs lines must meet American Society for Testing and Materials (ASTM F887) Arc Test and OSHA 1926.954(b)(1)(ii) requirements to show material will not burn through when slag hits it. Typically, wire-rope or para-aramid webbing meet these standards. Other synthetic fiber web SRLs can be cut, burned, melted, or otherwise damaged during such operations. In addition to the SRL, remember that workers’ harnesses, slings, or other fall protection webbing may need to be fire-resistant.
Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance

Temporary or permanent horizontal lifelines provide workers with the flexibility to move safely on bridges and/or scaffold structures for inspection, maintenance, and construction activities. But preventing falls through the use of horizontal lifelines requires planning, properly engineered systems, proper fall protection equipment, and hands-on training.

**Horizontal Lifeline (HLL) Concepts**

Temporary and permanent horizontal lifeline systems require user equipment such as a full body harness, a shock-absorbing lanyard, or an anti-ratcheting self-retracting lifeline, to ensure 100% fall protection at all times. The equipment must comply with the Occupational Safety and Health Administration (OSHA) arresting force limitations of 1,800 pounds or less [29CFR1926.502(d)(16)(iii)]. It should be easy to use and comfortable to wear. There are four basic steps to keep in mind when choosing fall protection equipment:

- **Have a qualified person assess the fall hazard**: What kind of work is the crew doing and where are the fall hazards located? Different stages of the bridge inspection, maintenance, and construction may require different forms of fall protection.

- **Plan for falls**: What will happen in the case of a fall? Think about the structures below the crew and their fall clearance. Ensure workers will not strike structures below. Plan for prompt rescue. Both unassisted and assisted rescue measures must be provided [29CFR1926.502(d)(20)]. In addition, employers must be prepared to provide emergency first aid to a fall victim within 3-4 minutes [29 CFR 1926.50(c) and OSHA Letter of Interpretation dated January 16, 2007 to Pro Med Training Center].

- **Select the appropriate equipment for the job**: Think about the level of comfort and mobility needed from the equipment and the work location. Ensure the full body harness is sized properly. The harness must be snug fitting to the body and legs. Ensure the harness is not too tight and the worker has full range of movement. If it is too loose, a worker’s shoulders can come out of the harness in the event of a head first fall. In the event of a fall, if the leg straps are too loose, significant and permanent injuries may happen to worker’s scrotum and testicles.

- **Properly train workers, supervisors, and competent persons**: When using safety products, even the smallest things make a very big difference. Competent persons and workers must be trained in the most effective and quickest ways to make adjustments to fall protection systems. Competent persons and workers must be able to recognize and avoid potential problems [29CFR1926.503(a)(1)]. The competent person has the authority to stop work until hazards are corrected [29CFR1926.32(f)]. The best employer safety programs always allow all employees to call for timeout to evaluate potentially unsafe and unhealthy conditions.

**Installation of Horizontal Lifeline Systems**

Horizontal lifeline systems can be job-built or they can be pre-engineered/commercially available systems with built-in shock absorbers. The shock absorber provides catenary* in the line in order to safely take the arresting forces applied by the worker’s fall. The sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points.

A job-built horizontal lifeline can also be used if properly engineered with the proper size of wire rope and attached to two substantial anchorage points on the job site with enough catenary in the line to ensure an engineered safety factor of two [29CFR1926.502(d)(8)].

Regardless of the horizontal lifeline system, the systems shall be designed, installed, and used under the supervision of a qualified person as defined by OSHA [29CFR1926.32(m)]. ANSI/ASSE Z359.2 Section 5.4 states horizontal lifelines sustain two times the maximum tension in the horizontal line during the fall arrest in the direction applied by lifeline forces.

*NOTE: Catenary means that the line has sag, resulting in the line being limp, not tight between the two connection/anchorage points; in engineering terms, a parabolic curve.
Horizontal Lifeline Systems (continued)

Below is a diagram for a typical pre-engineered/commercially available system with built-in shock absorbers. As discussed, the sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points. This sag, while essential for the operation of the horizontal lifeline system, introduces two factors that must be accounted for in installation and use.

- **Sag increases the fall distance.** The natural sag in a horizontal lifeline (B) increases with the length of system. A 20-foot system may sag only 1 inch or so, but a 100-foot system can have as much as 1 foot of natural sag at its center point. Combined with sag caused by loading in a fall, the total fall distance may vary from 18 feet to 40 feet.

- **Sag impacts the location of the worker after a fall.** Because of the sag, workers who fall on a horizontal lifeline tend to migrate to the center point of the lifeline. This poses two challenges to assure that the worker will not smash into an obstruction while migrating to the low point in the line after a fall and to assure that rescue is possible at all points along the horizontal lifeline.

![Diagram of horizontal lifeline system](source: www.safetydirect.ca)

This fact sheet offers only the briefest introduction to horizontal lifeline systems. Its main purpose is to highlight some of the technical issues involved and to motivate you to look carefully and use qualified persons when setting up such a system.

**ARTBA Work Zone Safety Consortium**

American Road and Transportation Builders Association  ■  U.S. Department of Transportation Federal Highway Administration
National Asphalt Pavement Association  ■  Texas A&M Transportation Institute
International Union of Operating Engineers  ■  FOF Communications
Community College Consortium For Health and Safety Training  ■  American Association of State Highway and Transportation Officials

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**What Is a Swing Fall?**

If the anchor in a personal fall arrest system (PFAS) is not directly above a worker’s head at 0° at all times, then any fall will include a horizontal direction. The horizontal direction makes the fall a ‘swing fall’ or pendulum fall.

The greater the angle from the anchor to the worker:
- the greater the arc of the swing fall
- the faster the velocity or speed of the swing fall
- the longer the vertical fall (free fall)

As the arc and velocity increase, so does the likelihood of impact with objects in the path of the swing fall.

The maximum arc of a swing fall is typically defined by degrees off center from the anchor, added to both sides of the center line. In practice, the arc of the fall will be somewhat less, because the energy of the horizontal movement, which is greatest when the fall begins, will diminish as the swing fall crosses the point of the overhead anchor (0°).

A swing fall can generate a lot of horizontal impact force. A worker in a swing fall can easily reach 20+ miles per hour in the horizontal direction. (A method for calculating swing fall speed appears on the reverse of this sheet.) A face, shoulder, arm, or back smashing into equipment or a structural member will cause serious harm or death for a worker.

**Set Maximum Work Ranges**

Swing falls can be minimized by working as directly below the anchor as possible (0° line). To reduce the risk of a swing fall, a company’s fall plan should set up a maximum work range from the anchor point to be calculated and enforced by the competent person. Many PFAS manufacturers recommend no more than 30° and others recommend 22.5° or less.

In the diagram on the left, the 0° line is directly below the anchor. The anchor is 20 feet above the working surface.

The 30° lines define a work range of about 8 feet out from the anchor line (0°). The 22.5° lines define a range of about 6 feet from 0°.

For an anchor lower than 20 feet, the work range shrinks proportionately.

A worker anchored at or near the working surface is at increased risk of a swing fall.

If the anchor is less than 5 feet above the working surface (right), then the safe work range is drastically reduced to 2.5 feet out from the anchor line (0°).

**Workers often exceed the maximum safe work range and this increases swing fall momentum and free fall distance.**

*Source: FOF.*
How To Calculate Free Fall Distance and Speed in a Swing Fall

If an employee works more than 30° from the anchor, in a swing fall the line will be much longer than if the worker fell directly at 0°. The farther from 0°, the farther the free fall and the faster the falling worker moves.

- Measure the length of the line from the anchor to the D-ring at 0°. This represents the length of the line if no swing fall condition existed. Call it \( B \). *
- Measure the length of the line from the anchor to the D-ring at the farthest work range along the edge. Call it \( C \).
- Find the difference between \( B \) and \( C \). Call this \( L. L \) is the vertical distance of the free fall.
- To find the speed, multiply \( L \times 32 \times 2 \times 2 \). This is the effect of gravity on a falling object — 32 feet per second per second. Then convert feet per second to miles per hour.

**EXAMPLE AT RIGHT:**

\[
\begin{align*}
B & \text{ (anchor to D-ring at 0°) } = 13 \text{ feet} \\
C & \text{ (anchor to maximum) } = 22 \text{ feet}
\end{align*}
\]

\[
\begin{align*}
\text{Horizontal} & \quad L & \quad \text{Effect of Gravity} \\
\text{Speed} & = 9 & = 34 \text{ ft per sec}
\end{align*}
\]

\[
\begin{align*}
\text{Miles Per} & \quad \text{FPS} & \quad \text{Sec to Hrs} & \quad \text{Speed} \\
\text{Hour} & = (34 \times 3600) & = 5280 & = 23 \text{ MPH}
\end{align*}
\]

* If you only know \( B \), you can calculate \( C \): Measure the maximum distance on the edge from the \( 0^\circ \) position at which the worker will work (A). Use \( A^2 + B^2 = C^2 \) to find the maximum length of line in the event of a swing fall. \( C = \sqrt{A^2 + B^2} \)

**How To Set Maximum Work Ranges**

The chart on the left is an easy tool for finding the maximum work range for a given anchor height. These examples show how the chart works:

1. For work 20 feet from the overhead anchor point (0°), how high must the anchor point be placed above the D-Ring?
   - Look across the chart horizontally to the 20-foot mark. This is the desired horizontal working distance from anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring at left (H). The anchor point would have to be at 50 feet above the D-Ring.  
2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will the worker have?
   - Find the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow down to the axis for the horizontal working distance from the anchor point (D): about 15 feet.

**Vertical Free Fall Distance (L) = 9 Feet**

**Exceeds OSHA free fall limit of 6 feet.**

![Swing Fall Speed = 23 MPH](Source: FOF)

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Preventing Suspension Trauma

Arresting a fall is only the first step in preventing injury or death. Even if the arrest does not cause injury, a fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time. Too often, a worker is saved by a personal fall arrest system (PFAS), only to succumb to suspension trauma while waiting for rescue.

Many safety managers, superintendents, and foremen assume their job is done if they limit total PFAS arresting force to 1,800 pounds and prevent impact injury during a fall. Unfortunately, post-fall suspension trauma and the time needed for rescue are often left out of fall protection plans. For a fallen worker awaiting rescue, suspension trauma can become a life-threatening emergency if not handled properly. Therefore, a fall protection plan should always include a plan for rescue.

What Is Suspension Trauma?

Suspension trauma happens when a fallen worker is suspended in a harness with legs hanging. While arteries near the fronts of the legs continue pumping blood, the harness straps act like tourniquets on the veins in the backs of the legs and prevent used (deoxygenated) blood returning to the heart. If circulation is impeded enough, the heart rate will abruptly slow and reduce oxygen to the brain.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Immediate Steps to Reduce the Risk of Suspension Trauma

The best way to slow progression of suspension trauma is to stand. When a worker stands, the leg muscles must contract, which puts pressure on the veins. This pressure, along with a series of one-way valves within the veins, helps blood return to the heart and reduces the amount of blood pooling in the legs. A fallen worker can stand in one of several ways:

- **Suspension trauma relief straps:** A fallen worker can deploy trauma relief straps, creating a loop that the worker steps into and presses against to stand up. Relief straps are typically packaged in two pouches that attach to each side of a harness.

- **Onsite work equipment:** The onsite rescue team may be able to bring a ladder, an aerial lift, or other equipment for the suspended worker to stand on.

- **Structural member:** The onsite rescue team may be able to pull the suspended worker over to a structural member, a lower level, or the ground.

Planning and Preparation

Everyone who works at heights must be fully trained in fall protection. Training should include PFAS rescue and first aid/CPR.

A specific rescue plan must be developed for each jobsite. The supervisor should assign duties, such as who calls 911 and who performs the rescue. The supervisor should evaluate in advance how onsite work equipment could be used. Employers should also provide specialized equipment:

- suspension trauma relief straps,
- self-rescue devices, and/or
- technical rescue equipment for assisted rescue by trained onsite workers. This may include pulley systems, brake-tube systems, winch systems, controlled descent devices, rope ladders, or other devices.
The Rescue

Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Post-rescue death is caused by the heart’s inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Do not put a rescued worker in a horizontal position – whether conscious or not.

If the rescued worker does not have any apparent injuries from the fall, the worker should be placed in a sitting position with knees close to the chest. The position is often called a ‘W’ position. The fall victim should remain in the ‘W’ position for at least 30 minutes to prevent the oxygen-deprived blood returning to the heart suddenly.

When Emergency Medical Services (EMS) arrive onsite, ensure that they know to treat the rescued worker for possible suspension trauma. Inform them how long the worker was suspended.

**Employers must plan for and practice fall rescue. Even if self-rescue is the primary plan, a fallen worker may not be able to perform self-rescue, so all workers using PFAS must be trained and prepared to perform assisted rescue.**

A Sample Fall Rescue Plan is available from ARTBA.

Before a Fall

- All personnel should be trained that suspension in an upright condition for longer than 5 minutes can be fatal.
- Workers should be trained to try to move their legs in the harness and try to push against any footholds.
- Workers should receive hands-on training on hanging in a harness and should try to get their legs as high as possible and their heads as close to horizontal as possible.
- Workers should not be permitted to work alone in a harness.
- Workers should have a way to signal for help, such as a whistle.
- The rescue plan and training should ensure that rescue of a fall victim happens in less than 5 minutes.
- Onsite work equipment should be evaluated for potential use in a fall rescue.
- Harnesses should be selected for the specific job application and must consider design, compliance, convenience of use, fit, potential arrest injury, and suspension trauma.

After a Fall

- Suspended workers should try to move their legs in the harness and try to push against any footholds, such as relief staps.
- Suspended workers should try to get their legs as high as possible and their heads as close to horizontal as possible.
- If the worker is suspended upright, emergency measures must be taken to remove the worker from suspension or move the fallen worker into a horizontal posture or at least to a sitting position prior to the rescue.
- Rescuers must be aware that post-rescue death may happen if a victim is moved too rapidly to a horizontal position. Moving a worker too quickly to a horizontal position is likely to allow a large volume of used (deoxygenated) blood to move to the heart, causing cardiac arrest.
- Rescuers must be aware of the first aid measures to prevent suspension trauma.

References

1. Illinois Region VII EMS, Emergency Medical Services, an alliance of six EMS Systems with nearly 5,000 EMS providers. A PowerPoint presentation for EMS responders can be downloaded at http://www.regionviiems.com/forms/SCC%20CE%20April%202013.pdf

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See Emergency Medical Responder advice on the back of this card.

Fall Arrest Suspension Trauma
MEDICAL EMERGENCY CARD
KEEP THIS CARD IN YOUR WALLET FOR USE IN FALL RESCUE

A fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time and treated properly.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Suspension trauma traps deoxygenated blood in the veins of the legs.

DO NOT PLACE A RESCUED WORKER IN A HORIZONTAL POSITION. If there is no apparent injury, place the rescued worker in a sitting position with knees close to the chest. This is called the W position. The worker should remain in this position for at least 30 minutes.

See Emergency Medical Responder advice on the back of this card.
Fall Arrest Suspension Trauma
**EMERGENCY MEDICAL SERVICES (EMS) ALERT**

A worker experiencing a fall arrested by a Personal Fall Arrest System (PFAS) can die from suspension trauma (orthostatic shock). Fall arrest suspension can trap deoxygenated blood in the veins of the legs.

Post-rescue death is caused by the heart's inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Do not put a rescued worker in a horizontal position, whether conscious or not.

See OSHA Bulletin on Suspension Trauma
www.osha.gov/dts/shib/shib032404.html

**American Road & Transportation Builders Association Work Zone Safety Consortium**

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This document is intended to provide guidance for developing fall rescue plans for bridge contractors. The Occupational Safety and Health Administration’s (OSHA) regulation 29 CFR 1926.502(d)(20) states: “The employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves.” Employers should develop a site specific plan for rescue of workers who have fallen. Bridge contractors can consult American National Safety Institute/American Society of Safety Engineers (ANSI/ASSE) Z359.2 (Minimum Requirements for a Comprehensive Managed Fall Protection Program) for additional information in developing a comprehensive fall protection plan. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.)

(a) PURPOSE:

(1) The purpose of this plan is to establish companywide guidelines for responding to a fall at heights of 6 feet and above. This plan should ensure that the victim’s health risks are minimized during a fall. This plan also addresses the need to recognize the hazards of suspension trauma, how to prevent suspension trauma and how to treat suspension trauma. (A fact sheet on Preventing Suspension Trauma is available from ARTBA.)

(2) The rescue plan shall ensure the rescuer(s) is/are protected by fall protection equipment 100% of time during the rescue attempt and that the rescue is conducted in a safe and professional manner.

(b) APPLICATION:

(1) This plan will apply at all locations where personnel are employed.

(2) The requirements of this plan are to be observed by all personnel involved in working at heights of 6 feet and above or where a fall hazard exists.

(3) This plan shall be reviewed and/or included in any Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) when working at heights of 6 feet and above or where working above hazardous equipment regardless of fall height.

(c) DEFINITIONS:

(1) **Rescue Plan** – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface and is suspended in a full body harness, to include self-rescue or mechanically aided rescue.

(2) **Self Rescue** – An act or instance of an employee using their fall protection and rescue equipment to perform a rescue without having to put other workers at risk.

(3) **Mechanically Aided Rescue** – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface using mechanical means.

(4) **Suspension Trauma** – The medical effects of immobilization in a vertical position. The medical term is orthostatic incompetence or orthostatic shock.

(d) CONTRACTOR RESPONSIBILITIES:

(1) **Employee** –
   (i) Trained and familiar with the content of the company’s Fall Protection Plan and policies.
   (ii) Able to understand and evaluate the risks associated with working at heights.
   (iii) Trained and competent in the use of fall protection equipment prior to working at heights.
   (iv) Able to report unsafe conditions and/or behaviors to the Person-In-Charge.
   (v) All employees utilizing fall protection equipment, including the designated competent person, lead rescuer and rescue personnel shall be trained in first aid, cardiopulmonary resuscitation (CPR), and suspension trauma (orthostatic incompetence or orthostatic shock).
(d) **CONTRACTOR RESPONSIBILITIES (cont.):**

(2) **Authorized Rescuer** –

(i) Trained in rescue techniques by a competent rescuer trainer before exposed to a fall hazard or a potential rescue application.

(ii) Shall be retrained when the nature of the work, the workplace, or the methods of control or rescue change to such an extent that prior training is not adequate.

(iii) Training for authorized rescuers shall include physical demonstrations by trainees on how to inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.

(iv) Training shall include at least the following:

- Fall hazard recognition;
- Fall hazard elimination and control methods;
- Applicable fall protection and rescue OSHA regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards;
- How to use written fall protection and rescue procedures; and
- Pre-use equipment inspection procedures.

(v) Authorized rescuer update training shall be conducted at least annually to stay current with the fall protection and rescue educational requirements.

(vi) Authorized rescuers shall be evaluated by a competent rescuer or competent rescue trainer at least annually to ensure competency of the duties assigned. Hands on performance evaluation will be conducted that covers all equipment that the person is authorized to use.

(vii) The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the date(s) of the training, and the signature of the person who was trained and the signature of the trainer. The latest training certification shall be maintained. (An **Employee Fall Protection Training Record** is available from ARTBA).

(3) **Competent Rescuer** –

(i) Competent rescuers shall be trained by a competent rescue trainer.

(ii) Training for competent rescuers shall include physical demonstrations by trainees on how to properly select, inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.

(iii) Training shall include use of all types of equipment and systems used in locations where rescues may be required, including pre-use inspection procedures, installation, component compatibility, descent control devices, secondary rescue systems, packaging methods to minimize further injury, dismantling, storage and the common hazards associated with each system and component.

(iv) Competent rescuer training shall include at least the following information:

- Fall hazard elimination and control methods;
- Applicable fall protection and rescue regulations;
- Assessment of fall hazards to determine rescue methods;
- Responsibilities of designated persons under OSHA Standards 29 CFR 1926 Subpart M (Fall Protection) and Subpart R (Steel Erection);
- Detailed inspection and recording of rescue equipment components and systems;
- Rescue systems assessment and determining when a system is unsafe;
- Development of written fall protection rescue procedures; and
- Selection and use of non-certified and certified anchorage points.
- First aid, CPR and recognition and treatment of suspension trauma (Orthostatic Incompetence).

(v) Competent rescue training shall be conducted at least annually.
Sample Fall Rescue Plan for Bridge Work

(e) PROCEDURE:

(1) A rescue plan must be a part of the Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) for any job that is to be performed that requires work at heights at or above 6 feet. In all cases where an employee falls and rescue procedures must be implemented call 911. Ensure that the fire department and Emergency Medical Service (EMS) responders are informed that suspension trauma may be involved with the rescue. Initially after a fall that is arrested by fall protection equipment, the fallen worker may appear to have suffered no injury. Often, internal injuries may not be immediately apparent but may be fatal if not medically treated properly. The rescue plan shall include consideration of the following rescue types and circumstances:

(i) Self-Rescue: If the competent person supervising those working at heights makes proper choices in the equipment to be used and the worker uses the equipment properly, then 90% of fallen workers will be able to perform self-rescue which should include:

- Worker will climb back up to the level from which they fell. The worker will usually use an extension ladder to climb back to the bridge deck or surface from which they have fallen.
- Worker will return to the bridge deck, ground, or other surface and receive prompt medical care and evaluation.
- Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(ii) Assisted Self-Rescue: Assisted Self-Rescue with mechanically aided hauling/rope system that is manually operated. The goal of the assisted self-rescue is for the fallen worker to perform as much of the rescue as possible with assistance. Therefore, if self-rescue is not possible then the worker must be safely retrieved by the use of an assisted self-rescue system which uses a manual mechanical advantage for a hauling/rope system. The following guidelines should be used during a manual mechanically aided rescue:

- The static load requirements: The mechanical device may be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
- The haul line may be swung over or lowered to the worker, who will grab the lifeline hook and secure it to the appropriate body support D-ring. As a general rule it is not recommended snapping two snap hooks from separate fall protection equipment into the same D-ring. The front D-ring may be also be used to attach to the haul line. In self-rescue the front D-ring may give the fallen employee greater control staying away from fixed objects in front of them. Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member, all rescue personnel involved in the rescue and the employee (if capable) must all verify that a secondary fall protection or haul line used with a self-retracting lifeline (SRL) has a positive connection. Verification of positive connection to the haul line may be made by the worker hoisting themselves up where the arrest lanyard or SRL is visibly slack. Once all involved have verified a positive connection to the rescue equipment, the lead member of the rescue team may order releasing the lanyard or self-retracting life line that arrested the worker’s fall.
- If possible, the fallen worker will raise or lower themselves to the appropriate work platform or ground. If the fallen worker cannot raise or lower themselves, then a member of the rescue team must raise or lower the fallen worker to the platform or ground. After the employee has been rescued from their arrested fall, the employee will receive prompt medical attention for all serious injuries, including treatment for possible suspension trauma. (A fact sheet on Preventing Suspension Trauma is available from ARTBA.)
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(iii) Mechanically Aid Assisted Rescue: Rescue with manual mechanically aided hauling/rope system by a rescue team member(s). If the workers injuries prevent them from attaching themselves to the rescue system, both self-rescue and assisted self-rescue are not options, and a fully assisted rescue must be performed.
(e) PROCEDURE (cont.):

- The static load requirements: The mechanical device will be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
- A rescue team member must attach the mechanical device haul line to the fallen worker’s fall arrest system. This can be performed by accessing the worker and attaching to the worker’s harness or use a rescue pole for the attachment. The rescue team could also attach a rescue grab to the lanyard or vertical lifeline.
- The rescue team will raise or lower the fallen worker to the appropriate work platform or ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

(iv) Aerial Work Platform Assisted Rescue: Rescue with mechanically aided aerial work platform. Another means to perform an assisted rescue is with an aerial work platform using the following guidelines:

- At least one rescue worker who has been trained to safely operate the aerial work platform will get into the aerial lift and make sure there is a second fall protection device such as a shock absorbing lanyard or SRL available for the fallen worker who is being rescued.
- The aerial lift will be maneuvered into position and then raised up under the worker to be rescued.
- The rescue worker will attach the second lanyard or SRL from the aerial work platform to the fallen worker to be rescued.
- Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member and all rescue personnel involved in the rescue and the fall victim (if capable) must all verify that a positive connection from the aerial work platform to the fall victims harness. The rescue worker after receiving permission from the lead rescue worker, may disconnect the lanyard or SRL involved in arresting the worker’s fall.
- Lower the worker to the ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal flotation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water and that the employees will not use or be required to use fall protection equipment as well. When working on a high bridge with a significant fall hazard employees should be utilizing fall protection. The fall impact forces to water from a high bridge could be severe enough to cause death.

(v) Mobile Crane Supported Platform Assisted Rescue: Rescue by use of a personnel platform attached to mobile crane. Another means to perform an assisted rescue is with a personnel platform suspended by a crane using the following guidelines:

- The crane operator must be trained to perform crane operations using a personnel platform for rescue of a fallen worker.
- The employer and the crane operator must ensure that the crane, the personnel platform, and fall protection required is in accordance with OSHA Crane Standard in 29 CFR 1926.1431.
- If the employer anticipates the possible need to use a personnel platform suspended by a crane to rescue a potential fall victim, the crane operator and the rescue team will perform a trial lift prior to worker exposure to a fall hazard. All rescue equipment and the personnel platform must be in the ready position to be attached and suspended by the crane to perform the rescue in a timely manner.
(e) PROCEDURE (cont.):

- At least one rescue worker will get onto the personnel platform and make sure there is a second fall protection device such as a shock absorbing lanyard or SRL available for the fallen worker who is being rescued.
- The crane will be maneuvered into position and then raised up under the worker to be rescued in the same manner as the trial lift. The rescue worker will attach the second lanyard or SRL from the aerial work platform to the fallen worker to be rescued.
- Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member and all rescue personnel involved in the rescue and the fall victim (if capable) must all verify a positive connection from the personnel platform anchorage point to the fall victims harness. The rescue worker after receiving permission from the lead rescue worker may disconnect the lanyard or SRL involved in arresting the worker’s fall.
- Lower the worker to the ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal flotation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water when working from an aerial lift or suspended by a crane. When working on a high bridge with a fall hazard of 40 feet or more to the water fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA states a PFD alone is not adequate if the height of the potential fall is 40 or more feet or there is a potential of striking a structural member during the fall or striking something floating in the water. In these cases the employee must be tied off.

(vi) Crane as an Anchorage Point: Anchoring to the load line of a crane. When using the load line of a crane as an anchorage point ensure compliance with OSHA Standard 29 CFR 1926.1423(g), (j) and (k) is mandatory. Personal fall arrest system or rescue equipment for fall arrest is permitted to be anchored to the crane/derrick's hook (or other part of the load line) where all of the following requirements are met:

- A qualified person has determined that the set-up and rated capacity of the crane/derrick (including the hook, load line and rigging) meets or exceeds the requirements of a 5,000 lbs. (22.2 kN) anchorage point per employee attached. If one rescue worker and one employee to be rescued are secured to the hook, load line or rigging than the rated capacity for the crane at the radius and angle of the boom must exceed 10,000 lbs. (44.4 kN) on the load chart for the crane.
- The crane operator must be at the work site and informed that the equipment is being used as an anchorage point for fall protection or for fall rescue equipment.
- No load is suspended from the load line when the personal fall arrest system is anchored to the crane/derrick's hook (or other part of the load line).
- Training. The employer must train each employee who may be exposed to fall hazards while on, or hoisted by, equipment covered by OSHA's crane standard on all of the following: The requirements of this rescue plan and OSHA’s fall protection standard.
(f) ANCHORAGE POINTS (ANSI/ASSE Z359.2 Section 5.4):

<table>
<thead>
<tr>
<th>Strict Load Requirements</th>
<th>Non-Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2 kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
<td></td>
</tr>
</tbody>
</table>

(g) ASSEMBLY, MAINTENANCE, INSPECTION, DISASSEMBLY PROCEDURES

Assembly and disassembly of all rescue and equipment will be done according to manufacturers’ recommended procedures. A copy of the manufacturer’s product manuals for each type of rescue and fall protection equipment used will be on-site.

A site specific list of rescue and fall equipment used on this job will be developed by site management. Rescue personnel will conduct a visual inspection of all rescue and fall protection equipment daily or before each use. Any defective rescue and fall protection equipment will be tagged and removed from service immediately. The manufacturer’s recommendations for maintenance and inspection will be followed.

(h) FALL PROTECTION ENFORCEMENT/DISCIPLINARY POLICY

*Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand if they knowingly violate the company’s policy they will be terminated. Employees must understand if they knowing violate the company’s policy of fall protection they will be terminated as well. The company’s enforcement and disciplinary policy should address actions that will be taken against sub-contractors as well. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company’s fall protection policy or retraining with a written counseling statement.*

(i) REFERENCES TO ANSI / ASSE Z359 FAMILY OF CONSSENSUS STANDARDS

The following five ANSI/ASSE Z359 series of consensus standards provides for a “systems approach” to implementation of a fall protection program:

- **Z359.0** Definitions and Nomenclature Used for Fall Protection and Fall Arrest
- **Z359.1** Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components
- **Z359.2** Minimum Requirements for a Comprehensive Managed Fall Protection Program
- **Z359.3** Safety Requirements for Positioning and Travel Restraint Systems
- **Z359.4** Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components

(j) AUTHORIZATION:

<table>
<thead>
<tr>
<th>Signature:</th>
<th>Date:</th>
</tr>
</thead>
</table>

Name: ____________________________
Title: ____________________________

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.
Sample Rescue Plan

IMPORTANT: This document is intended to provide guidance only for developing site-specific working at heights rescue plans for bridge contractors.

Date: _______ Job Description: __________________________________________

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>*Method of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated Competent Person</td>
<td></td>
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<tr>
<td>Lead Rescue Person</td>
<td></td>
<td></td>
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<tr>
<td>Assistant Rescuer(s)</td>
<td></td>
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<tr>
<td>Emergency Contact(s)</td>
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</tbody>
</table>

*Denotes: Verbal (Face-to-face), Radio Channel (specify channel), phone number or other forms of communication.

Onsite Rescue Equipment (indicate a yes or no for each box)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Pulley System</th>
<th>Brake-Tube System</th>
<th>Winch System</th>
<th>Controlled Descent</th>
<th>Rope Ladder</th>
<th>Skiff</th>
<th>Life Ring with 90 feet of rope</th>
<th>First Aid Kit</th>
<th>Stokes basket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder</td>
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<tr>
<td>Rescue Pole</td>
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<tr>
<td>Rescue Rope</td>
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<tr>
<td>Crane as Anchorage Point</td>
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<tr>
<td>Crane with a Personnel Platform</td>
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<tr>
<td>Scaffold</td>
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<tr>
<td>Aerial Work Platform</td>
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<tr>
<td>Vertical Rescue &amp; Escape System</td>
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<tr>
<td>Self-Retractable Lifeline</td>
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</tbody>
</table>

Pre-Planning for Rescue and Fall Protection Equipment

<table>
<thead>
<tr>
<th>Yes/No</th>
<th>Rescue and Fall Protection Planning</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Have alternatives to using fall arrest equipment been considered?</td>
<td></td>
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<tr>
<td></td>
<td>Has rescue equipment been inspected and found in serviceable condition?</td>
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<tr>
<td></td>
<td>Is equipment adequate for the rescue plan?</td>
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<tr>
<td></td>
<td>Have communications devices been identified, located, and tested?</td>
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</tr>
<tr>
<td></td>
<td>Are all rescuers familiar with the use of the rescue equipment?</td>
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<tr>
<td></td>
<td>If working over water, is there a skiff and life rings?</td>
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<tr>
<td></td>
<td>Are PFDs worn by worker when working over water?</td>
<td></td>
</tr>
</tbody>
</table>

Describe tasks to be done prior to work to prevent a fall and the step-by-step process to be followed in the event of a fall.

Pre-Work Tasks and Response Procedures

<table>
<thead>
<tr>
<th>#</th>
<th>Pre-Work Task</th>
<th>#</th>
<th>Response Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AHA (Activity Hazard Analysis) and/or JSA (Job Safety Analysis) has been developed for this task</td>
<td>1</td>
<td>Call 911</td>
</tr>
<tr>
<td>2</td>
<td>Perform trial test of rescue equipment</td>
<td>2</td>
<td>Notify Emergency Fall Rescue Team</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
<td>Notify First Aid/CPR Personnel</td>
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<tr>
<td>4</td>
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<td>4</td>
<td>Notify Site Management</td>
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<td>5</td>
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<td>5</td>
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<td>6</td>
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</tbody>
</table>
This company has a written fall protection program that details its responsibilities under Occupational Safety and Health Administration (OSHA) fall protection requirements: 29 CFR 1926 Subparts E (Personal Protective Equipment 1926.105 - 106), L (Scaffolding 1926.450 - 454 and Appendices A - E), M (Fall Protection 1926.500-503 and Appendices A - E), R (Steel Erection 1926.760 - 761 and Appendices D and G) and CC (Cranes and Derricks 1926.1423). All employees will be trained by a competent person* who is qualified prior to any job assignment where fall protection is required. The training will enable each employee to recognize fall hazards and to follow appropriate procedures that minimize the hazards. This record certifies the following employees have been trained to recognize fall hazards and to use appropriate fall protection systems and methods to minimize exposure to the hazards, as required in 1926.503(b).

**Employee Name:**

---

### FALL PROTECTION EQUIPMENT COVERED IN TRAINING

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature* (see page 2)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
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<tr>
<td>Shock-Absorbing Lanyard</td>
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<tr>
<td>Work Positioning Lanyard</td>
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<tr>
<td>Self-Retracting Lifeline (SRL)</td>
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<tr>
<td>Restraint Line</td>
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<tr>
<td>Horizontal Lifeline</td>
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<tr>
<td>Vertical Lifeline</td>
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<tr>
<td>Incline Line</td>
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<tr>
<td>Rope Grab</td>
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<tr>
<td>Deceleration Device</td>
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<tr>
<td>Locking Snap Hooks</td>
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<tr>
<td>Locking Carabiners</td>
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<tr>
<td>Controlled Descent/ Self-Rescue</td>
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</tbody>
</table>

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This material is based on work supported by the Federal Highway Administration under Grant Agreement No. DTFH61-11-H-00029. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the Federal Highway Administration.

This publication does not constitute a national standard, specification, or regulation.
### FALL PROTECTION EQUIPMENT COVERED IN TRAINING (continued)

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Straps</td>
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<tr>
<td>Anchorage</td>
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<tr>
<td>Safety Nets</td>
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<tr>
<td>FP on Aerial Work Platforms (AWP)</td>
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<tr>
<td>FP on Crane-Supported Personnel Platforms</td>
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<tr>
<td>Other:</td>
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<tr>
<td>Other:</td>
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</tbody>
</table>

**Warning Access Zones and Safety Monitors:** For leading edge work [29 CFR 1926.501(b)(2)] and precast concrete [29 CFR 1926.501(b)(12)] work where the employer can demonstrate that it is infeasible or creates a greater hazard to utilize conventional fall protection equipment, the employer may decide to use controlled access zones and safety monitors. The OSHA position is that it is feasible and the employer has the burden to provide proof that it is infeasible and to prepare a site specific plan in accordance with 29 CFR 1926.502(k). The ARTBA position is that the conventional fall protection is feasible in these activities.

### OSHA STANDARD / COMPANY PROGRAM COVERED IN TRAINING

<table>
<thead>
<tr>
<th>OSHA Standard / Company Program in Training</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company’s Written Fall Protection Program</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Company’s Written Fall Protection Rescue Plan</td>
<td></td>
<td></td>
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<tr>
<td>Trained to Perform Rescue of Fallen Worker Suspended by Fall Arrest</td>
<td></td>
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<tr>
<td>Subpart E (Safety Nets) 29 CFR 1926.105</td>
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<tr>
<td>Subpart E (Working Over Water) 29 CFR 1926.106</td>
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<tr>
<td>Subpart L (Scaffolds/Aerial Lifts) 29 CFR 1926.450-454 and Appendix A - E</td>
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<tr>
<td>Subpart M (Fall Protection) 29 CFR 1926.500-503 Appendix B - E</td>
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<tr>
<td>Subpart R (Steel Erection) 29 CFR 1926.750 - 761 and Appendix A - H</td>
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<tr>
<td>Subpart CC (Crane Standard) 29 CFR 1926.1423 and 1431</td>
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</tr>
</tbody>
</table>

*I certify that I have trained the employee/worker for the equipment, company programs and/or OSHA standards listed above. I also certify that I am a competent person who is qualified to provide this training. A Competent Person is one who is capable of identifying existing and predictable hazards [OSHA 29 CFR 1926.32(f)]; authorized to take prompt corrective measures to eliminate hazards [OSHA 29 CFR 1926.32(f)]; and qualified to train employees in all aspects of fall protection covered in OSHA Subpart M [29 CFR 1926.503 (Subpart M)].*
This template is intended to aid bridge contractors in developing an overall fall protection plan that includes use of conventional fall protection systems (guardrails, personal fall arrest, personal fall restraint, safety nets, and/or work positioning devices). Such an overall plan can then be adapted for specific work sites. The written plan tells how to control each fall hazard. It lists the fall protection measures to be used, how they are to be used, and who is responsible for supervision and training.

If a bridge contractor wishes to declare an exception to the use of conventional fall protection, Occupational Safety and Health Administration (OSHA) regulation requires a site-specific fall protection plan for using alternative fall protection methods. Such an exception can be made only when the contractor demonstrates that use of conventional systems is not feasible and/or will create a greater hazard. OSHA and the Occupational Safety and Health Review Commission (OSHRC) have placed the burden of establishing ‘infeasibility’ and ‘greater hazard’ claims on the employer. When contractors declare an exception, they must implement a written site-specific fall protection plan which complies with 29 CFR 1926.502(k), in lieu of implementing conventional fall protection.

Bridge contractors can declare an exception to use of conventional fall protection equipment only for leading edge work and precast concrete work. The ARTBA position is that conventional fall protection equipment is feasible and that implementation of the use of conventional fall protection systems will not create a greater hazard.

**THIS BRIDGE FALL PROTECTION PLAN WILL BE AVAILABLE ON THE JOBSITE FOR INSPECTION**

All employees who will be working on this job site will be made aware of the fall hazards and will understand the means to prevent falls and to minimize the injury or death potential of a fall. All employees will be informed of the company policy of enforcement and discipline for this plan. All employees will also be aware of the employer’s rescue plan in the event of a fall.

(a) Site-Specific Job Information:

<table>
<thead>
<tr>
<th>Company Name:</th>
<th>Date of Plan:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Site Location:</td>
<td></td>
</tr>
<tr>
<td>Site Superintendent:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Site Foreman:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Designated Qualified Person:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Designated Competent Person:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Employees Authorized To Use Fall Protection Equipment:</td>
<td>Cell/Radio Channel:</td>
</tr>
</tbody>
</table>
(b) Specific Fall Hazards Associated with the Bridge Work Area:

Include locations and dimensions for the hazards, such as but not limited to openings, leading edge work, deck perimeters, bridge structural members, etc. Work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, etc.

(c) Method of Personal Fall Arrest (PFAS) or Personal Fall Restraint (PFRS):

For all PFAS or PFRS equipment, include the type of equipment, manufacturer’s name, and the model number.

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
<td></td>
<td>Relief Straps</td>
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<tr>
<td>Shock-Absorbing Lanyard</td>
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<td></td>
<td>Anchorage</td>
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<tr>
<td>Work Positioning Lanyard</td>
<td></td>
<td></td>
<td>Safety Nets</td>
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<td></td>
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<tr>
<td>Self-Retracting Lifeline (SRL)</td>
<td></td>
<td></td>
<td>Other:</td>
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<td></td>
</tr>
<tr>
<td>Restraint Line</td>
<td></td>
<td></td>
<td>Other:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Lifeline</td>
<td></td>
<td></td>
<td>Other:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Lifeline</td>
<td></td>
<td></td>
<td>Other:</td>
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<tr>
<td>Incline Line</td>
<td></td>
<td></td>
<td>Other:</td>
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<tr>
<td>Rope Grab</td>
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<td>Other:</td>
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<tr>
<td>Deceleration Device</td>
<td></td>
<td></td>
<td>Other:</td>
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<tr>
<td>Locking Snap Hooks</td>
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<td>Other:</td>
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<tr>
<td>Locking Carabiners</td>
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<td>Other:</td>
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<tr>
<td>Controlled Descent/ Self-Rescue</td>
<td></td>
<td></td>
<td>Other:</td>
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</tbody>
</table>
(c) Method of Personal Fall Arrest or Personal Fall Restraint (cont.):

Anchorage points: according to ANSI/ASSE Z359.2 Section 5.4

<table>
<thead>
<tr>
<th>Static Load Requirements</th>
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<tbody>
<tr>
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<tr>
<td>Non-Certified</td>
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<tr>
<td>Fall Arrest System</td>
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<tr>
<td>Work Positioning Systems</td>
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<tr>
<td>Restraint &amp; Travel Systems</td>
</tr>
<tr>
<td>Rescue Systems</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
</tr>
</tbody>
</table>

(d) Assembly, Maintenance, Inspection, Disassembly Procedure for Personal Fall Arrest or Personal Fall Restraint:

Assembly and disassembly of all personal fall arrest, personal fall restraint, work positioning systems, horizontal lifelines, and rescue systems will be done according to manufacturers’ recommended procedures. The specific types of equipment to be used on this job are listed in paragraph (c) on page 2. A copy of the manufacturer’s product manual for each type of fall protection equipment and fall protection system used will be onsite.

A visual inspection of all equipment will be done before each use. The manufacturer’s recommendations for maintenance and inspection will be followed. Any defective equipment will be tagged and removed from service immediately. (A competent person must inspect the jobsite, materials, and equipment on a frequent/regular basis [OSHA Subpart C 1926.20].)

Employees responsible for inspection are listed below:

<table>
<thead>
<tr>
<th>Employee Name:</th>
<th>Cell/Radio Channel:</th>
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</table>

(e) Handling, Storage and Securing of Tools and Material:

All materials, equipment, and tools not in use while aloft shall be secured against accidental displacement. Include locations and dimensions for the specific hazards.
(f) Overhead Protection:

OSHA requires hardhats on all job sites with overhead hazards. It is recommended that hardhats be worn on all construction sites whether or not overhead hazards exist. When working aloft, workers will wear chin straps to secure their hardhats from falling off.

Warning signs will be posted to caution of existing hazards whenever they are present. For example, when steel erection, leading edge work, and pre-cast concrete erection activities are being performed above, then warning signs, barricades and/or danger tape shall clearly mark the area to prohibit workers from accidentally entering the area. In some cases, debris nets may be used if a condition warrants additional protection.

Toeboards will be used on scaffolding, personnel platforms, and aerial work platforms. If tools and/or equipment could fall over the toeboard, then additional safety measures such as – but not limited to – the use of screens to keep the tool and/or equipment on the deck of the scaffolding, personnel platform, and/or aerial work platform will be taken.

In addition to materials being hoisted, employees shall be protected from other falling objects. The bridge contractor will prohibit other construction processes below steel erection, leading edge work, and pre-cast concrete erection activities unless overhead protection is provided in addition to hardhats. If the bridge contractor is not the controlling contractor, the bridge contractor will request that the controlling contractor also communicate and enforce prohibited activity below steel erection, leading edge work, and pre-cast concrete erection activities.

(g) Rescue of Suspended or Injured Worker:

Rescue activities will be performed in accordance with the site-specific rescue plan. (A Sample Fall Rescue Plan for Bridge Work and a fact sheet on Preventing Suspension Trauma are available from ARTBA.)

(h) Working Over Water:

OSHA states that fall protection equipment is required when employees are working 6 feet or more over water. When employees are protected by fall protection 100% of the time (guardrails or personal fall arrest), OSHA does not require the use of a personal floatation device (PFD).

When employees are working over or near water and 100% fall protection is not provided, the requirements of 29 CFR 1926.106 also apply. Where a fall hazard exists of 6 feet or greater to the water, employees must be provided a fall protection harness and a PFD. For comfort, the employee should be provided a combination harness/PFD instead of requiring both a harness and a PFD to be worn simultaneously.

When employees work from aerial lifts or platforms suspended by a crane over water, tie-off using PFAS/PFRS may not be required. OSHA states by letter of interpretation that employees are not required to be tied off when working over water in an aerial lift or from a suspended platform. The employer should evaluate on a case-by-case basis whether only a PFD will be utilized over water when working from an aerial lift or suspended by a crane.

When employees work on a high bridge over water, fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA also states a PFD alone is not adequate if there is a potential of striking a structural member during the fall or striking an object in the water. In these cases the employee must be tied off.

When working over or near water, bridge contractors must ensure:
- Employees are provided with a PFD.
- Prior to and after each use, the PFD must be inspected for defects which would alter strength or buoyancy. Defective PFDs will not be used.
- Ring buoys with at least 90 feet of line must be provided and readily available for emergency rescue operations. Distance between ring buoys will not exceed 200 feet.
- At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.
(i) Guardrail Systems:

In general, guardrails are the preferred fall protection system when feasible. Whenever feasible, the company will select and install guardrail systems before resorting to use of personal fall arrest (PFAS) or personal fall restraint. Include locations where use of guardrail systems is feasible and guardrails will be installed.

(j) Safety Nets:

Where feasible, safety nets are an effective fall protection system. Like guardrails, nets require no special effort on the part of workers who are protected by them. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Include locations where use of safety nets is feasible and safety nets will be installed.

(k) Training Program:

An *Employee Fall Protection Training Record* is available from ARTBA. Company training program requirements for employees who might be exposed to fall hazards will include:

- Trained by a competent person concerning proper use and limitations of fall protection equipment before exposed to a fall hazard.
- Training must be conducted *before* employees are allowed to be exposed to fall hazards and directed to use fall protection equipment.
- Employees who have rescue duties will be trained from a competent person on how to properly rescue an employee who has had their fall arrested by fall protection equipment.
- Employees will be retrained when the nature of the work, the workplace, or the methods of control or type of fall protection equipment change to such an extent that prior training is no longer adequate.
- Training of employees in proper use of fall protection equipment will include physical demonstrations by trainees. Demonstrations by employees will verify their knowledge, skills, and proper application of fall protection equipment. Trainees will demonstrate how to inspect, anchor, assemble, and use the fall protection and rescue equipment in locations where they work.
(k) Training Program (cont.):

- Training shall include at least the following:
  - Nature of fall hazards in the work area and fall hazard recognition.
  - Fall hazard elimination and control methods.
  - Correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used.
  - Use/operation of guardrail systems, PFAS, PFRS, safety net systems, and/or work positioning systems to be used.
  - All standards contained in OSHA 1926 Subpart M and R and other applicable OSHA fall protection and rescue regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards.
  - Requirements of this fall protection plan and rescue plan/procedures.
  - Pre-use equipment procedures.

- Training shall be conducted at least annually to stay current with fall protection and rescue educational requirements.

  The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the training date(s), the signature of the person trained, and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA.)

NOTE: OSHA requires that the trainer must be a competent person who is qualified in the following areas:
- The nature of fall hazards in the work area;
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used;
- The use and operation of guardrail systems, personal fall arrest systems, personal fall restraint systems, safety net systems, work positioning, controlled access zones, and other protection to be used;
- The correct procedures for the handling and storage of equipment and materials and the erection of overhead protection;
- The role of employees in fall protection plans; and
- The standards in 29 CFR 1926 Subpart M and R, and the requirements in ANSI/ASSE Z359 series as noted in paragraph (l) below.

(l) Fall Protection Enforcement and Disciplinary Policy:

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand that they will be terminated if they knowingly violate the company’s policy. Employees must understand if they violate the company’s fall protection policy they will be terminated as well. The company’s enforcement and disciplinary policy should also address actions that will be taken against subcontractors. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company policy or retraining with a written counseling statement.

(m) References to ANSI/ASSE Z359 Family of Consensus Standards:

Five ANSI/ASSE Z359 consensus standards provide a “systems approach” to implementation of a fall protection program.

<table>
<thead>
<tr>
<th>Z359.0</th>
<th>Definitions and Nomenclature Used for Fall Protection and Fall Arrest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z359.1</td>
<td>Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components</td>
</tr>
<tr>
<td>Z359.2</td>
<td>Minimum Requirements for a Comprehensive Managed Fall Protection Program</td>
</tr>
<tr>
<td>Z359.3</td>
<td>Safety Requirements for Positioning and Travel Restraint Systems</td>
</tr>
<tr>
<td>Z359.4</td>
<td>Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components</td>
</tr>
</tbody>
</table>

(n) Authorization:

<table>
<thead>
<tr>
<th>Signature:</th>
<th>Date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
</tr>
</thead>
</table>

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.

ARTBA Work Zone Safety Consortium

American Road and Transportation Builders Association • U.S. Department of Transportation Federal Highway Administration
National Asphalt Pavement Association • Texas A&M Transportation Institute
International Union of Operating Engineers • FOF Communications
Community College Consortium For Health and Safety Training • American Association of State Highway and Transportation Officials

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Work Zone Safety Consortium
(202) 289-4434

Together, we represent all segments of the roadway construction industry.

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INTERNATIONAL UNION OF OPERATING ENGINEERS (IUOE)
www.iuoe.org

COMMUNITY COLLEGE CONSORTIUM FOR HEALTH AND SAFETY TRAINING (CCCHST)
http://www.hmtri.org/ccchst/ccchst_index.html

NATIONAL ASPHALT PAVEMENT ASSOCIATION (NAPA)
www.asphaltpavement.org

NATIONAL LOCAL TECHNICAL ASSISTANCE PROGRAM ASSOCIATION
http://www.nitapa.org

FEDERAL HIGHWAY ADMINISTRATION
U.S. Department of Transportation
www.fhwa.dot.gov

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www.transportation.org

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www.tti.tamu.edu

FOF COMMUNICATIONS
Washington DC
www.fofcom.com
Preface

The U.S. Department of Transportation, Federal Highway Administration (FHWA) has jurisdiction for roadway bridges and the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) has regulatory authority for safety practices in bridge construction, inspection, maintenance, and repair.

According to the FHWA report *Safety and Health on Bridge Repair, Renovation and Demolition Projects* (Publication Number: FHWA-RD-98-180) Chapter 3, Section 2: Fall Protection, “To protect employees when they are exposed to fall hazards, some form of fall protection must be used. The most common forms of fall protection are guardrails, personal fall arrest systems, hole covers, and safety nets. Any one or all of these forms of fall protection may be used on construction worksites. The current OSHA standards also require that employees receive training regarding fall protection issues, and that the training is documented.”

This document provides technical advice on fall protection requirements, fall protection systems selection, fall protection plans, employee training, training documentation, and fall rescue plans.

Objectives

This document contains a series of fact sheets on key issues in the selection and use of fall protection in bridge construction, inspection, and maintenance.

This document contains the following fact sheets:

• Fall Protection Systems for Bridge Work
• Fall Protection for Bridge Contractors in 4 Main Steps
• Guide to Selecting Fall Protection Systems for Bridge Work
• OSHA Fall Protection Standards Bridge Contractors Must Know
• Selecting PFAS Lanyards and Connectors for Bridge Work
• Advantages of Self Retracting Lifelines for Bridge Work
• Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance
• Preventing Swing Falls in Bridge Work
• Preventing Suspension Trauma
• Fall Arrest Suspension Trauma Medical Emergency Wallet Card
• Sample Fall Rescue Plan for Bridge Work
• Employee Fall Protection Training Record
• Sample Fall Protection Plan for Bridge Work

To obtain printable PDFs of the facts sheets and/or this document, visit [http://www.workzonesafety.org](http://www.workzonesafety.org).

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Fall Protection Systems for Bridge Work

Occupational Safety and Health Administration (OSHA) fall protection regulations provide detailed definitions of conventional fall protection systems. The OSHA regulations apply to any work 6 feet or more above levels to which workers could fall. The OSHA fall protection standards appear in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards. The ARTBA position is that use of conventional fall protection equipment is feasible in bridge work.*

What Is Fall Protection?
Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. Two basic categories of conventional fall protection equipment systems are available for bridge contractors:

- **Fall prevention systems** that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- **Fall arrest systems** that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

Fall Prevention Systems
Guardrails are vertical barriers erected to prevent workers falling to a lower level. Guardrails are an engineering control. Guardrails may be cable, metal, plastic, or wood. Guardrail systems for fall protection are usually different from highway guardrails designed to keep vehicles on the road. Guardrails in place on bridges may not meet OSHA requirements.

(a) Existing bridge guardrails may not meet OSHA requirements. This guardrail is too short and lacks toeboards. Photo source: NBC. (b) This existing guardrail appears to meet OSHA requirements. Photo source: BravoFence. (c) When existing guardrails are not adequate or are not in place, then temporary guardrail can be installed. Photo source: J-Safe.

A standard guardrail consists of a top rail, midrail, toeboard, and uprights. The toeboards prevent tools and materials falling off the work area. The top rail must be 39 to 45 inches above the working surface and must withstand at least 200 pounds of force without deflecting to a point less than 39 inches above the working surface. The midrail must be midway between the top rail and the working surface and must withstand 150 pounds of force. The toeboards must be a minimum of 3.5 inches high and withstand 50 pounds of force. Guardrails may include mesh or wire as greater protection from falling objects.

Guardrail systems provide many advantages. Chief among these is that guardrails are a passive fall prevention system, so workers are not required to operate the equipment after it is installed, though regular inspections by a competent person are necessary. In general, guardrails are the preferred fall protection system when feasible.

*Note: This fact sheet covers conventional fall protection as defined by OSHA. 29 CFR 1926.501(b)(2)(i) requires use of guardrail systems, safety nets, or personal fall arrest systems for employees doing leading edge work. Controlled Access Zones (CAZ) are not presented here because CAZ is not conventional fall protection. A CAZ can be used only if a bridge contractor can demonstrate that use of conventional fall protection is infeasible or creates a greater hazard.
Personal Fall Restraint Systems (PFRS) prevent users falling any distance. A PFRS acts as a leash and keeps a worker’s center of gravity from reaching a fall hazard. Like a personal fall arrest system (PFAS), a PFRS includes anchorage, a body harness, connectors, and a lanyard or lifeline. PFRS anchor strength requirements are less than PFAS but, due to the likelihood of misuse or mishap, comparable strength is recommended by experts. A PFRS is more difficult to set up and use than is a PFAS. Like PFAS, PFRS is active fall protection because workers must operate it.

Photo source: OSHA.

Fall Arrest Systems

Safety nets are hung beneath or around work areas to catch workers or debris. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Safety nets have three main parts and three optional parts:

- net mesh
- support cables
- mounting brackets
- outriggers
- cantilever arms
- various adapters

Safety nets are classified as fall arrest because nets catch workers after a fall. Nets do not prevent falling. Unlike PFAS, safety nets do not require workers to actively do anything to make nets work. Therefore, safety nets are called passive fall protection systems.

Personal fall arrest systems (PFAS) are designed to catch a worker who has fallen. It must hold the fallen worker safely until rescue. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. A PFAS must limit maximum arresting force to 1,800 pounds. The free fall distance cannot exceed 6 feet. PFAS is an active fall protection system because workers must operate it. Thinking of the PFAS parts as A-B-C-D helps users remember how the system works and the importance of each part in the system. Here are the A-B-C-Ds of PFAS:

A. Anchor is a secure point at which to attach a lifeline, lanyard, deceleration device, and/or rescue equipment. The best body harness, lanyard, and connectors are nothing without proper anchorage. Anchorage must be capable of supporting at least 5,000 pounds per worker.

B. Body harness consists of shoulder straps, shoulder strap retainer, D-ring, waist strap, thigh straps, sub-pelvic support, and adjustment buckles. The straps distribute fall arrest forces over the upper thighs, pelvis, chest, and shoulders. The D-ring (attachment point) is typically located between the shoulder blades.

C. Connectors are usually D-rings, carabiners, and/or locking snaphooks. (See the ARTBA fact sheet Selecting PFAS Lanyards and Connectors for Bridge Work.)

D. Descent and rescue devices are used to retrieve or lower a fallen worker. These devices and the techniques/skills to use them are an essential part of the fall protection program. (See the ARTBA fact sheets Preventing Suspension Trauma and Sample Fall Rescue Plan.)

Positioning devices are body belt or body harness systems rigged to allow a worker to be supported on an elevated vertical surface, such as a wall. In construction work, a positioning device may be used only to protect a worker on a vertical work surface. These devices may permit a fall of up to 2 feet, but positioning devices are not designed as fall arrest. Examples of use include concrete form work or installation of reinforcing steel.

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Fall Protection for Bridge Contractors in 4 Main Steps

For the third year in a row, fall protection was #1 on the Occupational Safety and Health Administration (OSHA) Top 10 list of the most cited violations, with 8,241 fall protection citations issued in 2014, according to OSHA. Now, more than ever, all bridge contractors must learn how to implement comprehensive fall protection programs.

Bridge contractors can achieve 100% fall protection by taking four key steps:
- plan
- provide
- train
- enforce/evaluate

**Leading Cause of Death**
Falls are the leading cause of death in construction. Falls took the lives of 699 construction workers in 2013 alone. The majority of these fatal falls (82%) were falls to a lower level. Of the lower level falls, about 25% were from 10 feet or less while 75% were from heights of 11 feet and higher (with 55% falling between 11-29 feet and 20% falling 30 feet or more).

The following fatalities illustrate the risks for workers on bridges throughout the United States.
- A 45-year old bridge worker fell 70 feet to his death from the Mount Hope Bridge in Connecticut.
- Two bridge workers, ages 53 and 63, fell 90 feet to their deaths from a bridge near Montgomery, Alabama.
- A 34-year old bridge worker fell 60 feet to his death from a bridge across Lake Washington near Seattle.

When bridge contractors implement effective fall protection programs, they increase worker safety and help prevent deaths and permanent injuries. OSHA, in partnership with the National Institute for Occupational Safety and Health (NIOSH) and National Occupational Research Agenda (NORA) – Construction Sector, has been waging a nationwide outreach campaign to raise awareness among workers and employers about common fall hazards in construction.

The campaign focuses on how falls from ladders, scaffolds, bridge structures, and bridge decks can be prevented. Lives can be saved through an important and highly effective 4-step process: plan, provide, train, and enforce/evaluate.

**Step 1: Plan**
A well-designed fall protection plan written by a qualified person is the first step to reducing risks and saving lives. OSHA mandates that the fall protection plan must be developed by a qualified person with relevant knowledge and training in order to successfully implement an appropriate fall protection program.

A comprehensive bridge fall protection plan developed by a qualified person should include a statement of company

Fall Protection in 4 Steps (continued)

Policy signed by the highest level of management. The company policy must clearly state employee and supervisor responsibilities as well as enforcement measures and appropriate disciplinary actions. The bridge fall protection plan must also be site specific, with a detailed list of fall prevention measures.

The bridge contractor should designate the competent person(s) in writing. The competent person(s) must:

- Be responsible for implementing the fall protection plan
- Have absolute authority over the fall protection plan
- Have unquestioned authority to stop work and correct fall hazards
- Oversee documented inspections where fall protection measures are utilized
- Keep fall protection equipment maintenance records, records of prompt removal of defective equipment, incident reports, accident investigations records, and employee training records
- Prepare to train employees by acquiring or developing a training program

The fall protection plan must include performing a thorough hazard analysis to determine the areas of risk and methods of engineering out the hazards, if possible. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.) Selection of fall protection systems should be made at this stage. Contingency plans and appropriate rescue equipment should be selected. Finally, a method for enforcing the plan and evaluating effectiveness should be developed.

ARTBA’s Fact Sheet Guide to Selecting Fall Protection Systems for Bridge Work provides detailed descriptions of fall protection equipment and a flow chart to aid selection of fall protection in bridge work.

**Step 2: Provide**

To protect employees working at 6 feet or higher above lower levels, employers must provide the correct fall protection equipment for the job. To help prevent falls, employers must also provide the correct types of ladders, scaffolds, and safety gear.

All fall protection systems and scaffold systems must be designed and/or installed under the supervision of a qualified person. OSHA defines a qualified person as one who “… has proven knowledge, skills, experience, education, certification, or professional standing to solve or resolve problems related to the subject matter, the work, or the project.” [29 CFR 1926.32(m)]

**Step 3: Train**

At a minimum, each employee who might be exposed to fall hazards must be trained by a competent person who is qualified in the following areas [29 CFR 1926.503(a)(2)]:

- The nature of fall hazards in the work area
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems
- The use and operation of guardrail systems, personal fall arrest systems, safety net systems, and/or other protections
- The OSHA fall protection standard

ARTBA offers training products and informational documents, including an Employee Fall Protection Training Record, to help bridge contractors deliver and document required fall protection training for employees.

**Step 4: Enforce/Evaluate**

The company fall protection program must contain mechanisms for enforcing requirements and evaluating the effectiveness of the program. Enforcement mechanisms can include discipline within the normal chain of command, for example. Evaluation can include comparison reviews of training records and policy infractions as well as analysis of any accidents that might occur.

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**ARTBA Work Zone Safety Consortium**

- American Road and Transportation Builders Association
- National Asphalt Pavement Association
- International Union of Operating Engineers
- Community College Consortium For Health and Safety Training
- U.S. Department of Transportation Federal Highway Administration
- Texas A&M Transportation Institute
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Bridge work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, and other activities.

Occupational Safety and Health Administration (OSHA) fall protection regulations apply to any work 6 feet or more above levels to which workers could fall. OSHA fall protection standards are in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards.

**Fall Hazard Analysis**

OSHA requires bridge contractors to assess all the hazards of each job before work begins. One method for doing this is a *Job Hazard Analysis*. A Job Hazard Analysis is a systematic method for determining what specific hazards exist or may arise during work and what appropriate actions need to be taken to protect workers. In bridge work, the number one hazard is falls. Therefore, an analysis of fall hazards is essential. The contractor may do this or the contractor may assign the competent person for fall protection to complete the analysis.

Following the hazard analysis, a site-specific fall protection plan should be developed. (A *Sample Fall Protection Plan for Bridge Work* is available from ARTBA.) The written plan tells how to control each fall hazard. It should list the conventional fall protection measures to be used, how they are to be used, and who is responsible for supervision and training. At this point, the selection of appropriate and effective fall protection systems is a critical activity.

During this process, the contractor and/or the competent person will refer to the hierarchy of hazard controls to assess how the fall hazards will be addressed. In descending order, the hierarchy is:

- substitution (rarely applicable in construction)
- engineering controls, such as guardrail systems
- administrative procedures, such as restricted entry to controlled access zones
- personal protective equipment (PPE), such as a personal fall arrest system (PFAS)

Some fall protection systems are engineering controls. Some are PPE. Some are a combination.

**What Is Fall Protection?**

Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. (See ARTBA’s *Fall Protection Systems for Bridge Work.*) Two basic categories of fall protection systems are available for bridge contractors:

- Fall *prevention systems* that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- Fall *arrest systems* that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

**Fall Protection Flow Chart for Bridge Work**

The *Fall Protection Flow Chart For Bridge Work* on the reverse is a decision tool for analyzing fall hazards and fall protection needs for a bridge jobsite. Answering the questions in the chart can aid in the selection of fall protection systems.
No single standard of the Occupational Safety and Health Administration (OSHA) covers all the fall protection requirements a bridge contractor needs to know. A bridge contractor must be familiar with at least four subparts of OSHA standards. Further, OSHA standards are minimum standards, so knowledge of several standards of the American National Standards Institute (ANSI) covering fall protection is often also required. The table below provides a general overview of the relevant OSHA standards.

### OSHA Fall Protection Standards for Bridge Contractors (29 CFR 1926)

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</table>

*Working over water see [WWW.OSHA.GOV](http://www.osha.gov) for letter of interpretation dated September 28, 1999 linked to 1926.106(a).*

**Leading edge work requires conventional fall protection, unless the employer can demonstrate it is not feasible. Where the employer determines it is not feasible, a site-specific written plan in accordance with 1926.502(k) must be developed, implemented, and supervised by a competent person.**

***See OSHA's [WWW.OSHA.GOV](http://www.osha.gov) eTool and Directive CPL 02 01 034 for more detailed information and NIOSH Campaign to Prevent Falls in Construction [WWW.CDC.GOV/NIOSH/](http://www.cdc.gov/niOSH/).**

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In a personal fall arrest system (PFAS), a lanyard connects a body harness to an anchor or to a horizontal or vertical lifeline. Lanyards are typically made from 3-foot to 6-foot lengths of synthetic webbing or rope, or wire rope, with attached connectors such as snaphooks, carabiners, or other devices. Lanyards may have built-in shock absorbers to reduce the impact of a fall.

Ideally, a personal fall arrest system is designed, tested, and supplied as a complete system. However, it is common practice for PFAS components to be interchanged because some parts wear out more quickly. The employer should realize that not all components are interchangeable. Proper selection of compatible PFAS components is discussed on the reverse.

### Lanyard Length and Total Fall Clearance Distance

Selection of lanyards in bridge work must consider the **total fall clearance distance** of a potential fall. The total fall clearance distance is the vertical distance from the anchor to the nearest lower obstruction that a falling worker would impact, such as a structural member or the ground. Five basic factors make up this distance:

1. **Lanyard length**
2. **Deceleration distance**
3. **Estimated materials stretch**
4. **Estimated D-ring movement**
5. **Height of the suspended worker**

The illustration at left shows how these factors affect total fall clearance distance for a 6-foot worker using a 6-foot lanyard anchored overhead. Safely arresting the fall of a 6-foot worker using a 6-foot lanyard requires approximately 17.5 feet of clearance from the anchorage point to the nearest lower obstruction.

In cases where vertical lifelines or horizontal lifelines are used, calculations of total fall clearance distances must also include the slip of the rope grab plus lifeline stretch (vertical lifeline) or the displacement plus stretch of the lifeline (horizontal lifeline).

For anchorage below standing D-ring level, careful calculation and a larger shock-pack are required to control arresting force.

The required total fall clearance distance may be shortened in any setup by using a shorter lanyard (3, 4 and 5-foot lengths) or by using a self-retracting lifeline (SRL).

When selecting a lanyard for use in an aerial work platform (AWP), consult the operator’s manual to determine the recommended lanyard length. It is best to use a lanyard that will restrain the worker on the AWP and will not allow the worker to fall or be catapulted over a guardrail.

### Lanyard Length and Fall Force

Always select the shortest possible lanyard. The longer the lanyard, the longer the fall and the greater the fall forces. Even short falls can generate huge amounts of force. A 200-pound worker falling 10 feet is subject to 8,000 pounds of force on abrupt impact. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. Lanyards must be selected to limit free falls to no more than 6 feet and 1,800 pounds of force [CFR 1926.502(d)(16)(ii)].

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**NOTE:** Occupational Safety and Health Administration Standard 29 CFR 1926.502(d)(16)(iv) limits deceleration distance (B) to 3.5 feet. Source of other values: Introduction To Fall Protection. J. Nigel Ellis, Ph.D., CSP, P.E., CPE, 2012. OSHA Standard 29 CFR 1926.502(d) provides specifications for lanyards and does not directly mention ANSI or ANSI/ASSE consensus standards; however, the following OSHA webpage provides a list of various ANSI and ANSI/ASSE consensus standards relating to falls in the construction industry: [https://www.osha.gov/SLTC/fallprotection/construction.html](https://www.osha.gov/SLTC/fallprotection/construction.html).
Lanyard Specifications

Lanyards must display approval by the American National Standards Institute (ANSI) or the American National Standards Institute/American Society of Safety Engineer’s (ANSI/ASSE). Lanyards meeting the specifications of ANSI A10.32, ANSI/ASSE Z359.1 or ANSI/ASSE Z359.13 are permitted in the construction industry. ANSI/ASSE Z359.1 and Z359.13 are more stringent and more comprehensive than the ANSI A10.32.

Compatibility of Lanyards and Connectors

Connectors on lanyards – such as snap hooks, carabiners, scaffold hooks, or web loops – should be appropriate for the connection made. While a web loop may be appropriate for wrapping around a beam, a snap hook is more often used to connect to a vertical or horizontal lifeline. Scaffold hooks, due the larger opening, are often a better choice for anchors of convenience, such as rebar. When connecting directly to a lifeline, the connector may be an ascender/descender device.

PFAS components are often not interchangeable, whether from one manufacturer or not. In 29 CFR 1926 Subpart M Appendix C, OSHA reminds employers that they must evaluate the compatibility of all components before they are used to protect employees. Manufacturers issue numerous technical bulletins and educational pamphlets to aid in this evaluation.

In particular, OSHA requires employers to determine whether snaphooks are compatible with the members to which they are connected [29 CFR 1926.502(d)(5) and 1926.502(d)(6)(v)].

Connector Specifications

OSHA, ANSI A10.32 and ANSI/ASSE Z359.1 all require that snaphooks and carabiners be self-closing and self-locking. Opening and releasing snap hooks requires two consecutive deliberate actions to prevent rollout and other accidental openings of the snap hook or carabiner. Both ANSI standards are compliant with OSHA 29 CFR 1926.502 requirements.

All acceptable snap hooks or carabiners have a kilo-Newton (kN) rating engraved into the spine. Since 2007, the newest ANSI standard requires all fall protection hardware to have a minimum 16 kN (3,600 pounds) rating for the gate and 22.5 kN, (5,000 pounds) tensile load (ANSI Z359.1-2007, Section 3.2.1.4.). (A kilo-Newton equals about 225 pounds, which is a force of gravity and not static weight or mass. Force = mass times acceleration.)

Compliant connectors are clearly stamped with strength ratings. Avoid any connectors not so marked. Dealing with reputable manufacturers and distributors helps assure acquisition of compliant connectors.

In addition to kN and/or pounds ratings, the stamp should include: year of manufacture and ID, part number, load rating for major axis, load rating for gate and – for non-integral connectors – the ANSI Z359.1(07). Although OSHA stopped requiring the construction industry to meet ANSI 2007 in 2010, it is industry best practice to follow this standard.

Inspection of Lanyards and Connectors

Personal fall arrest system components must be inspected by the user prior to each use and by a competent person on a regular schedule. Defective components must be removed from service [OSHA 29 CFR 1926.502(d)(21)].
Advantages of Self Retracting Lifelines for Bridge Work

A self-retracting lifeline (SRL) is a deceleration device. The SRL contains a drum-wound line that may be either slowly extracted from or retracted onto the drum under slight tension during normal worker movement. A fall automatically locks the drum and arrests the fall. In some cases, despite higher costs, the SRL provides distinct advantages over a lanyard or lifeline and lanyard combination:

- **Reduced free fall compared with lanyard or lanyard-lifeline.** SRLs require less than two feet to arrest a free fall if the anchorage point is vertically above the worker versus 17.5 feet from an anchorage point for a shock-absorbing lanyard.

- **Reduced risk of impacting ground or other objects during a fall.** SRLs provide lower risk of hitting the ground or any other object at a lower level compared with the greater risk due to longer fall distance with a standard lanyard.

- **Easier rescue.** SRLs provide safer and easier rescue of a fallen worker compared with a standard lanyard. With an SRL, the fallen worker may self-rescue using a self-rescue pulley system attached near the SRL anchorage point. Some SRLs have built-in raise or lower options allowing coworkers to perform rescue with little risk. This must be part of the Rescue Plan. (A Sample Fall Rescue Plan is available from ARTBA.)

- **Reduced chance of tangles and trips while working.** SRLs reduce the chances of getting tangled and tripping compared with a standard anyard or lanyard and lifeline because the SRL retracts automatically.

Limitations

The horizontal distance for work from the anchor point with an SRL is limited, as it is with a lanyard and standard lifeline. The chart below shows safe maximum horizontal working distances for an SRL. Exceeding the distance shown in the chart may result in a hazardous pendulum swing. (Preventing Swing Falls is available from ARTBA.)

**Examples**

Horizontally, the distance a worker in an SRL can move from the anchor point is limited – as it is with a lanyard and standard lifeline. Evaluate the examples below to see how the chart works.

1. If a worker would like to be able to work 20 feet from the anchor point of the SRL, how high above must the anchor point be placed?
   - Look across the chart horizontally on the horizontal working distance axis to the 20-foot mark. This is the desired horizontal working distance from the anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring on the left (H). In the example to permit 20 feet of horizontal movement, the anchor would have to be at 50 feet above D-Ring height.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will be permitted?
   - In this case find the the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow that point down to the axis for horizontal working distance from anchor point (D). The answer is about 15 feet working distance.

Not all SRLs are created equal! Some use wire rope; others use webbing. The choice is frequently based on the work performed. Some SRLs are small and lightweight, good for light duty jobs or where work takes place near the anchor location. Others are heavier for long-term work and may have retractable lines up to 100 feet or more in length. Some can switch between fall restraint or fall arrest modes, and some have built-in automatic rescue options, which are more protective and expensive. Some SRLs are designed for leading edge work where a wire rope or web can pass over a sharp angle or edge, or when workers must anchor near their feet. In every case workers must know the limitations of their SRLs. Several of the important SRL selection and use considerations appear on page 2.
Important SLR Selection and Use Considerations

In bridgework SRLs may be used for leading edge work or where anchorage ends up near the worker’s feet. These circumstances result in additional hazards addressed only by SRLs rated for leading edge work. These hazards, listed below, have resulted in the American National Standards Institute (ANSI) August 2012 Standard Z359.14 on Self Retracting Devices (SRDs).

- **Increased Fall Distance**: When workers are attached at foot level, as they often are in leading edge applications, they will fall farther than they would if they were anchored at shoulder height or above. The required clearance when anchored at foot level varies by product. Therefore, contractors must follow the manufacturer’s instructions.

- **Lock-Up Speed**: Self-retracting lifelines react to a fall when the line accelerates out of the housing at a certain velocity, generally about 4.5 feet per second. When self-retracting lifelines are anchored at foot level, the lifeline does not achieve the required acceleration during a fall until after the user’s D-ring passes over the leading edge and below the level of the anchor. This means the user has already fallen about 5 feet before the self-retracting lifeline device will engage to arrest the fall.

- **Increased Fall Arrest Forces**: Falling farther means the impact on the body through the fall protection system will potentially be higher when the fall is arrested. This is why many leading edge and sharp edge rated products contain additional energy-absorbing devices.

- **Increased Potential for Swing Hazards**: Depending on a worker’s position when a falls begins, the worker may swing like a pendulum after the fall is arrested. While swinging is a hazard under any circumstances, the danger is compounded if the worker’s lifeline is strung taught over a sharp edge and sags back and forth. (See ARTBA’s *Preventing Swing Falls in Bridge Work*.)

Failure to use an SLR rated for leading edge work may result in excess fall forces applied to the worker’s body or to the wire rope or webbing being severed by the edge over which the fall has occurred resulting in serious injury or death.

**Further Considerations**


1. ...Consideration should be given to the particular work environment. For example, the presence of acids, dirt, moisture, oil, grease, etc., and their effect on the system, should be evaluated. Hot or cold environments may also have an adverse effect on the system. Wire rope should not be used where an electrical hazard is anticipated. ...

2. Where lanyards, connectors, and lifelines are subject to damage by work operations such as welding, chemical cleaning, and sandblasting, the component should be protected, or other securing systems should be used. ...

For example, if hot work of some kind – welding, torch-cutting, or burning – is performed, SRLs lines must meet American Society for Testing and Materials (ASTM F887) Arc Test and OSHA 1926.954(b)(1)(ii) requirements to show material will not burn through when slag hits it. Typically, wire-rope or para-aramid webbing meet these standards. Other synthetic fiber web SRLs can be cut, burned, melted, or otherwise damaged during such operations. In addition to the SRL, remember that workers’ harnesses, slings, or other fall protection webbing may need to be fire-resistant.

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Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance

Temporary or permanent horizontal lifelines provide workers with the flexibility to move safely on bridges and/or scaffold structures for inspection, maintenance, and construction activities. But preventing falls through the use of horizontal lifelines requires planning, properly engineered systems, proper fall protection equipment, and hands-on training.

Horizontal Lifeline (HLL) Concepts

Temporary and permanent horizontal lifeline systems require user equipment such as a full body harness, a shock-absorbing lanyard, or an anti-ratcheting self-retracting lifeline, to ensure 100% fall protection at all times. The equipment must comply with the Occupational Safety and Health Administration (OSHA) arresting force limitations of 1,800 pounds or less [29CFR1926.502(d)(16)(iii)]. It should be easy to use and comfortable to wear. There are four basic steps to keep in mind when choosing fall protection equipment:

- **Have a qualified person assess the fall hazard**: What kind of work is the crew doing and where are the fall hazards located? Different stages of the bridge inspection, maintenance, and construction may require different forms of fall protection.

- **Plan for falls**: What will happen in the case of a fall? Think about the structures below the crew and their fall clearance. Ensure workers will not strike structures below. Plan for prompt rescue. Both unassisted and assisted rescue measures must be provided [29CFR1926.502(d)(20)]. In addition, employers must be prepared to provide emergency first aid to a fall victim within 3-4 minutes [29 CFR 1926.50(c) and OSHA Letter of Interpretation dated January 16, 2007 to Pro Med Training Center].

- **Select the appropriate equipment for the job**: Think about the level of comfort and mobility needed from the equipment and the work location. Ensure the full body harness is sized properly. The harness must be snug fitting to the body and legs. Ensure the harness is not too tight and the worker has full range of movement. If it is too loose, a worker’s shoulders can come out of the harness in the event of a head first fall. In the event of a fall, if the leg straps are too loose, significant and permanent injuries may happen to worker’s scrotum and testicles.

- **Properly train workers, supervisors, and competent persons**: When using safety products, even the smallest things make a very big difference. Competent persons and workers must be trained in the most effective and quickest ways to make adjustments to fall protection systems. Competent persons and workers must be able to recognize and avoid potential problems [29CFR1926.503(a)(1)]. The competent person has the authority to stop work until hazards are corrected [29CFR1926.32(f)]. The best employer safety programs always allow all employees to call for timeout to evaluate potentially unsafe and unhealthy conditions.

Installation of Horizontal Lifeline Systems

Horizontal lifeline systems can be job-built or they can be pre-engineered/commercially available systems with built-in shock absorbers. The shock absorber provides catenary* in the line in order to safely take the arresting forces applied by the worker’s fall. The sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points.

A job-built horizontal lifeline can also be used if properly engineered with the proper size of wire rope and attached to two substantial anchorage points on the job site with enough catenary in the line to ensure an engineered safety factor of two [29CFR1926.502(d)(8)].

Regardless of the horizontal lifeline system, the systems shall be designed, installed, and used under the supervision of a qualified person as defined by OSHA [29CFR1926.32(m)]. ANSI/ASSE Z359.2 Section 5.4 states horizontal lifelines sustain two times the maximum tension in the horizontal line during the fall arrest in the direction applied by lifeline forces.

*NOTE: Catenary means that the line has sag, resulting in the line being limp, not tight between the two connection/anchorage points; in engineering terms, a parabolic curve.
Horizontal Lifeline Systems (continued)

Below is a diagram for a typical pre-engineered/commercially available system with built-in shock absorbers. As discussed, the sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points. This sag, while essential for the operation of the horizontal lifeline system, introduces two factors that must be accounted for in installation and use.

- **Sag increases the fall distance.** The natural sag in a horizontal lifeline (B) increases with the length of system. A 20-foot system may sag only 1 inch or so, but a 100-foot system can have as much as 1 foot of natural sag at its center point. Combined with sag caused by loading in a fall, the total fall distance may vary from 18 feet to 40 feet.

- **Sag impacts the location of the worker after a fall.** Because of the sag, workers who fall on a horizontal lifeline tend to migrate to the center point of the lifeline. This poses two challenges to assure that the worker will not smash into an obstruction while migrating to the low point in the line after a fall and to assure that rescue is possible at all points along the horizontal lifeline.

![Diagram of horizontal lifeline system with labels and measurements.](source: www.safetydirect.ca)

This fact sheet offers only the briefest introduction to horizontal lifeline systems. Its main purpose is to highlight some of the technical issues involved and to motivate you to look carefully and use qualified persons when setting up such a system.

**ARTBA Work Zone Safety Consortium**

- American Road and Transportation Builders Association
- National Asphalt Pavement Association
- International Union of Operating Engineers
- Community College Consortium For Health and Safety Training
- U.S. Department of Transportation Federal Highway Administration
- Texas A&M Transportation Institute
- FOF Communications
- American Association of State Highway and Transportation Officials

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What Is a Swing Fall?
If the anchor in a personal fall arrest system (PFAS) is not directly above a worker’s head at 0° at all times, then any fall will include a horizontal direction. The horizontal direction makes the fall a ‘swing fall’ or pendulum fall.

The greater the angle from the anchor to the worker:
- the greater the arc of the swing fall
- the faster the velocity or speed of the swing fall
- the longer the vertical fall (free fall)

As the arc and velocity increase, so does the likelihood of impact with objects in the path of the swing fall.

The maximum arc of a swing fall is typically defined by degrees off center from the anchor, added to both sides of the center line. In practice, the arc of the fall will be somewhat less, because the energy of the horizontal movement, which is greatest when the fall begins, will diminish as the swing fall crosses the point of the overhead anchor (0°).

A swing fall can generate a lot of horizontal impact force. A worker in a swing fall can easily reach 20+ miles per hour in the horizontal direction. (A method for calculating swing fall speed appears on the reverse of this sheet.) A face, shoulder, arm, or back smashing into equipment or a structural member will cause serious harm or death for a worker.

Set Maximum Work Ranges
Swing falls can be minimized by working as directly below the anchor as possible (0° line). To reduce the risk of a swing fall, a company’s fall plan should set up a maximum work range from the anchor point to be calculated and enforced by the competent person. Many PFAS manufacturers recommend no more than 30° and others recommend 22.5° or less.

In the diagram on the left, the 0° line is directly below the anchor. The anchor is 20 feet above the working surface.

The 30° lines define a work range of about 8 feet out from the anchor line (0°). The 22.5° lines define a range of about 6 feet from 0°.

For an anchor lower than 20 feet, the work range shrinks proportionately.

A worker anchored at or near the working surface is at increased risk of a swing fall.

If the anchor is less than 5 feet above the working surface (right), then the safe work range is drastically reduced to 2.5 feet out from the anchor line (0°).

Workers often exceed the maximum safe work range and this increases swing fall momentum and free fall distance.

Source: FOF.
How To Calculate Free Fall Distance and Speed in a Swing Fall

If an employee works more than 30° from the anchor, in a swing fall the line will be much longer than if the worker fell directly at 0°. The farther from 0°, the farther the free fall and the faster the falling worker moves.

- Measure the length of the line from the anchor to the D-ring at 0°. This represents the length of the line if no swing fall condition existed. Call it B.
- Measure the length of the line from the anchor to the D-ring at the farthest work range along the edge. Call it C.
- Find the difference between B and C. Call this L. L is the vertical distance of the free fall.
- To find the speed, multiply L x 32 x 2 x 2. This is the effect of gravity on a falling object — 32 feet per second per second. Then convert feet per second to miles per hour.

**EXAMPLE AT RIGHT:**

<table>
<thead>
<tr>
<th>L (anchor to D-ring at 0°)</th>
<th>13 feet</th>
<th>B</th>
<th>C</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>22 feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect of Gravity</td>
<td>22 - 13 = 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>FPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 x (32 x 2 x 2)</td>
<td>= √1152 = 34 ft per sec</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miles Per Hour</td>
<td>FPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 x 3600</td>
<td>/ 5280 = 23 MPH</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If you only know B, you can calculate C:
Measure the maximum distance on the edge from the 0° position at which the worker will work (A). Use $A^2 + B^2 = C^2$ to find the maximum length of line in the event of a swing fall. $C = \sqrt{A^2 + B^2}$

Vertical Free Fall Distance (L) = 9 Feet**
**Exceeds OSHA free fall limit of 6 feet.

Swing Fall Speed = 23 MPH

How To Set Maximum Work Ranges

The chart on the left is an easy tool for finding the maximum work range for a given anchor height. These examples show how the chart works:

1. For work 20 feet from the overhead anchor point (0°), how high must the anchor point be placed above the D-Ring?
   • Look across the chart horizontally to the 20-foot mark. This is the desired horizontal working distance from anchor point (D).
   • Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring at left (H). The anchor point would have to be at 50 feet above the D-Ring.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will the worker have?
   • Find the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   • Now follow down to the axis for the horizontal working distance from the anchor point (D): about 15 feet.
Preventing Suspension Trauma

Arresting a fall is only the first step in preventing injury or death. Even if the arrest does not cause injury, a fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time. Too often, a worker is saved by a personal fall arrest system (PFAS), only to succumb to suspension trauma while waiting for rescue.

Many safety managers, superintendents, and foremen assume their job is done if they limit total PFAS arresting force to 1,800 pounds and prevent impact injury during a fall. Unfortunately, post-fall suspension trauma and the time needed for rescue are often left out of fall protection plans. For a fallen worker awaiting rescue, suspension trauma can become a life-threatening emergency if not handled properly. Therefore, a fall protection plan should always include a plan for rescue.

What Is Suspension Trauma?
Suspension trauma happens when a fallen worker is suspended in a harness with legs hanging. While arteries near the fronts of the legs continue pumping blood, the harness straps act like tourniquets on the veins in the backs of the legs and prevent used (deoxygenated) blood returning to the heart. If circulation is impeded enough, the heart rate will abruptly slow and reduce oxygen to the brain.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Immediate Steps to Reduce the Risk of Suspension Trauma
The best way to slow progression of suspension trauma is to stand. When a worker stands, the leg muscles must contract, which puts pressure on the veins. This pressure, along with a series of one-way valves within the veins, helps blood return to the heart and reduces the amount of blood pooling in the legs. A fallen worker can stand in one of several ways:

- **Suspension trauma relief straps**: A fallen worker can deploy trauma relief straps, creating a loop that the worker steps into and presses against to stand up. Relief straps are typically packaged in two pouches that attach to each side of a harness.

- **Onsite work equipment**: The onsite rescue team may be able to bring a ladder, an aerial lift, or other equipment for the suspended worker to stand on.

- **Structural member**: The onsite rescue team may be able to pull the suspended worker over to a structural member, a lower level, or the ground.

Planning and Preparation
Everyone who works at heights must be fully trained in fall protection. Training should include PFAS rescue and first aid/CPR.

A specific rescue plan must be developed for each jobsite. The supervisor should assign duties, such as who calls 911 and who performs the rescue. The supervisor should evaluate in advance how onsite work equipment could be used. Employers should also provide specialized equipment:

- suspension trauma relief straps,
- self-rescue devices, and/or
- technical rescue equipment for assisted rescue by trained onsite workers. This may include pulley systems, brake-tube systems, winch systems, controlled descent devices, rope ladders, or other devices.
The Rescue

Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Post-rescue death is caused by the heart’s inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Do not put a rescued worker in a horizontal position – whether conscious or not.

If the rescued worker does not have any apparent injuries from the fall, the worker should be placed in a sitting position with knees close to the chest. The position is often called a ‘W’ position. The fall victim should remain in the ‘W’ position for at least 30 minutes to prevent the oxygen-deprived blood returning to the heart suddenly.

When Emergency Medical Services (EMS) arrive onsite, ensure that they know to treat the rescued worker for possible suspension trauma. Inform them how long the worker was suspended.

Employers must plan for and practice fall rescue. Even if self-rescue is the primary plan, a fallen worker may not be able to perform self-rescue, so all workers using PFAS must be trained and prepared to perform assisted rescue.

A Sample Fall Rescue Plan is available from ARTBA.

Before a Fall

- All personnel should be trained that suspension in an upright condition for longer than 5 minutes can be fatal.
- Workers should be trained to try to move their legs in the harness and try to push against any footholds.
- Workers should receive hands-on training on hanging in a harness and should try to get their legs as high as possible and their heads as close to horizontal as possible.
- Workers should not be permitted to work alone in a harness.
- Workers should have a way to signal for help, such as a whistle.
- The rescue plan and training should ensure that rescue of a fall victim happens in less than 5 minutes.
- Onsite work equipment should be evaluated for potential use in a fall rescue.
- Harnesses should be selected for the specific job application and must consider design, compliance, convenience of use, fit, potential arrest injury, and suspension trauma.

After a Fall

- Suspended workers should try to move their legs in the harness and try to push against any footholds, such as relief staps.
- Suspended workers should try to get their legs as high as possible and their heads as close to horizontal as possible.
- If the worker is suspended upright, emergency measures must be taken to remove the worker from suspension or move the fallen worker into a horizontal posture or at least to a sitting position prior to the rescue.
- Rescuers must be aware that post-rescue death may happen if a victim is moved too rapidly to a horizontal position. Moving a worker too quickly to a horizontal position is likely to allow a large volume of used (deoxygenated) blood to move to the heart, causing cardiac arrest.
- Rescuers must be aware of the first aid measures to prevent suspension trauma.

References

1. Illinois Region VII EMS, Emergency Medical Services, an alliance of six EMS Systems with nearly 5,000 EMS providers. A PowerPoint presentation for EMS responders can be downloaded at http://www.regionviiems.com/forms/SCC%20CE%20April%202013.pdf

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Fall Arrest Suspension Trauma
MEDICAL EMERGENCY CARD
KEEP THIS CARD IN YOUR WALLET FOR USE IN FALL RESCUE

A fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time and treated properly.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Suspension trauma traps deoxygenated blood in the veins of the legs.

DO NOT PLACE A RESCUED WORKER IN A HORIZONTAL POSITION.
If there is no apparent injury, place the rescued worker in a sitting position with knees close to the chest. This is called the W position. The worker should remain in this position for at least 30 minutes.

See Emergency Medical Responder advice on the back of this card.
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American Road & Transportation Builders Association Work Zone Safety Consortium

Fall Arrest Suspension Trauma
EMERGENCY MEDICAL SERVICES (EMS) ALERT

A worker experiencing a fall arrested by a Personal Fall Arrest System (PFAS) can die from suspension trauma (orthostatic shock). Fall arrest suspension can trap deoxygenated blood in the veins of the legs.

Post-rescue death is caused by the heart’s inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Do not put a rescued worker in a horizontal position, whether conscious or not.

See OSHA Bulletin on Suspension Trauma
www.osha.gov/dts/shib/oshi032404.html

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See OSHA Bulletin on Suspension Trauma
www.osha.gov/dts/shib/oshi032404.html

American Road & Transportation Builders Association Work Zone Safety Consortium
This document is intended to provide guidance for developing fall rescue plans for bridge contractors. The Occupational Safety and Health Administration’s (OSHA) regulation 29 CFR 1926.502(d)(20) states: “The employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves.” Employers should develop a site specific plan for rescue of workers who have fallen. Bridge contractors can consult American National Safety Institute/American Society of Safety Engineers (ANSI/ASSE) Z359.2 (Minimum Requirements for a Comprehensive Managed Fall Protection Program) for additional information in developing a comprehensive fall protection plan. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.)

(a) PURPOSE:

(1) The purpose of this plan is to establish companywide guidelines for responding to a fall at heights of 6 feet and above. This plan should ensure that the victim’s health risks are minimized during a fall. This plan also addresses the need to recognize the hazards of suspension trauma, how to prevent suspension trauma and how to treat suspension trauma. (A fact sheet on Preventing Suspension Trauma is available from ARTBA.)

(2) The rescue plan shall ensure the rescuer(s) is/are protected by fall protection equipment 100% of time during the rescue attempt and that the rescue is conducted in a safe and professional manner.

(b) APPLICATION:

(1) This plan will apply at all locations where personnel are employed.

(2) The requirements of this plan are to be observed by all personnel involved in working at heights of 6 feet and above or where a fall hazard exists.

(3) This plan shall be reviewed and/or included in any Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) when working at heights of 6 feet and above or where working above hazardous equipment regardless of fall height.

(c) DEFINITIONS:

(1) Rescue Plan – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface and is suspended in a full body harness, to include self-rescue or mechanically aided rescue.

(2) Self Rescue – An act or instance of an employee using their fall protection and rescue equipment to perform a rescue without having to put other workers at risk.

(3) Mechanically Aided Rescue – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface using mechanical means.

(4) Suspension Trauma – The medical effects of immobilization in a vertical position. The medical term is orthostatic incompetence or orthostatic shock.

(d) CONTRACTOR RESPONSIBILITIES:

(1) Employee –
   (i) Trained and familiar with the content of the company’s Fall Protection Plan and policies.
   (ii) Able to understand and evaluate the risks associated with working at heights.
   (iii) Trained and competent in the use of fall protection equipment prior to working at heights.
   (iv) Able to report unsafe conditions and/or behaviors to the Person-In-Charge.
   (v) All employees utilizing fall protection equipment, including the designated competent person, lead rescuer and rescue personnel shall be trained in first aid, cardiopulmonary resuscitation (CPR), and suspension trauma (orthostatic incompetence or orthostatic shock).
(d) CONTRACTOR RESPONSIBILITIES (cont.):

(2) Authorized Rescuer –
   (i) Trained in rescue techniques by a competent rescuer trainer before exposed to a fall hazard or a potential rescue application.
   (ii) Shall be retrained when the nature of the work, the workplace, or the methods of control or rescue change to such an extent that prior training is not adequate.
   (iii) Training for authorized rescuers shall include physical demonstrations by trainees on how to inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.
   (iv) Training shall include at least the following:
       ▪ Fall hazard recognition;
       ▪ Fall hazard elimination and control methods;
       ▪ Applicable fall protection and rescue OSHA regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards;
       ▪ How to use written fall protection and rescue procedures; and
       ▪ Pre-use equipment inspection procedures.
   (v) Authorized rescuer update training shall be conducted at least annually to stay current with the fall protection and rescue educational requirements.
   (vi) Authorized rescuers shall be evaluated by a competent rescuer or competent rescue trainer at least annually to ensure competency of the duties assigned. Hands on performance evaluation will be conducted that covers all equipment that the person is authorized to use.
   (vii) The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the date(s) of the training, and the signature of the person who was trained and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA).

(3) Competent Rescuer –
   (i) Competent rescuers shall be trained by a competent rescue trainer.
   (ii) Training for competent rescuers shall include physical demonstrations by trainees on how to properly select, inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.
   (iii) Training shall include use of all types of equipment and systems used in locations where rescues may be required, including pre-use inspection procedures, installation, component compatibility, descent control devices, secondary rescue systems, packaging methods to minimize further injury, dismantling, storage and the common hazards associated with each system and component.
   (iv) Competent rescuer training shall include at least the following information:
       ▪ Fall hazard elimination and control methods;
       ▪ Applicable fall protection and rescue regulations;
       ▪ Assessment of fall hazards to determine rescue methods;
       ▪ Responsibilities of designated persons under OSHA Standards 29 CFR 1926 Subpart M (Fall Protection) and Subpart R (Steel Erection);
       ▪ Detailed inspection and recording of rescue equipment components and systems;
       ▪ Rescue systems assessment and determining when a system is unsafe;
       ▪ Development of written fall protection rescue procedures; and
       ▪ Selection and use of non-certified and certified anchorage points.
       ▪ First aid, CPR and recognition and treatment of suspension trauma (Orthostatic Incompetence).
   (v) Competent rescue training shall be conducted at least annually.
Sample Fall Rescue Plan for Bridge Work

(e) PROCEDURE:

(1) A rescue plan must be a part of the Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) for any job that is to be performed that requires work at heights at or above 6 feet. In all cases where an employee falls and rescue procedures must be implemented call 911. Ensure that the fire department and Emergency Medical Service (EMS) responders are informed that suspension trauma may be involved with the rescue. Initially after a fall that is arrested by fall protection equipment, the fallen worker may appear to have suffered no injury. Often, internal injuries may not be immediately apparent but may be fatal if not medically treated properly. The rescue plan shall include consideration of the following rescue types and circumstances:

(i) **Self-Rescue**: If the competent person supervising those working at heights makes proper choices in the equipment to be used and the worker uses the equipment properly, then 90% of fallen workers will be able to perform self-rescue which should include:

- Worker will climb back up to the level from which they fell. The worker will usually use an extension ladder to climb back to the bridge deck or surface from which they have fallen.
- Worker will return to the bridge deck, ground, or other surface and receive prompt medical care and evaluation.
- Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(ii) **Assisted Self-Rescue**: Assisted Self-Rescue with mechanically aided hauling/rope system that is manually operated. The goal of the assisted self-rescue is for the fallen worker to perform as much of the rescue as possible with assistance. Therefore, if self-rescue is not possible then the worker must be safely retrieved by the use of an assisted self-rescue system which uses a manual mechanical advantage for a hauling/rope system. The following guidelines should be used during a manual mechanically aided rescue:

- The static load requirements: The mechanical device may be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
- The haul line may be swung over or lowered to the worker, who will grab the lifeline hook and secure it to the appropriate body support D-ring. As a general rule it is not recommended snapping two snap hooks from separate fall protection equipment into the same D-ring. The front D-ring may be also be used to attach to the haul line. In self-rescue the front D-ring may give the fallen employee greater control staying away from fixed objects in front of them. Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member, all rescue personnel involved in the rescue and the employee (if capable) must all verify that a secondary fall protection or haul line used with a self-retracting lifeline (SRL) has a positive connection. Verification of positive connection to the haul line may be made by the worker hoisting themselves up where the arrest lanyard or SRL is visibly slack. Once all involved have verified a positive connection to the rescue equipment, the lead member of the rescue team may order releasing the lanyard or self-retracting life line that arrested the worker’s fall.
- If possible, the fallen worker will raise or lower themselves to the appropriate work platform or ground. If the fallen worker cannot raise or lower themselves, then a member of the rescue team must raise or lower the fallen worker to the platform or ground. After the employee has been rescued from their arrested fall, the employee will receive prompt medical attention for all serious injuries, including treatment for possible suspension trauma. (A fact sheet on Preventing Suspension Trauma is available from ARTBA.)
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(iii) **Mechanically Aid Assisted Rescue**: Rescue with manual mechanically aided hauling/rope system by a rescue team member(s). If the workers injuries prevent them from attaching themselves to the rescue system, both self-rescue and assisted self-rescue are not options, and a fully assisted rescue must be performed.
Sample Fall Rescue Plan for Bridge Work

(e) PROCEDURE (cont.):

- The static load requirements: The mechanical device will be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
- A rescue team member must attach the mechanical device haul line to the fallen worker’s fall arrest system. This can be performed by accessing the worker and attaching to the worker’s harness or use a rescue pole for the attachment. The rescue team could also attach a rescue grab to the lanyard or vertical lifeline.
- The rescue team will raise or lower the fallen worker to the appropriate work platform or ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

(iv) Aerial Work Platform Assisted Rescue: Rescue with mechanically aided aerial work platform. Another means to perform an assisted rescue is with an aerial work platform using the following guidelines:
- At least one rescue worker who has been trained to safely operate the aerial work platform will get into the aerial lift and make sure there is a second fall protection device such as a shock absorbing lanyard or SRL available for the fallen worker who is being rescued.
- The aerial lift will be maneuvered into position and then raised up under the worker to be rescued.
- The rescue worker will attach the second lanyard or SRL from the aerial work platform to the fallen worker to be rescued.
- Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member and all rescue personnel involved in the rescue and the fall victim (if capable) must all verify that a positive connection from the aerial work platform to the fall victims harness. The rescue worker after receiving permission from the lead rescue worker, may disconnect the lanyard or SRL involved in arresting the worker’s fall.
- Lower the worker to the ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal flotation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water and that the employees will not use or be required to use fall protection equipment as well. When working on a high bridge with a significant fall hazard employees should be utilizing fall protection. The fall impact forces to water from a high bridge could be severe enough to cause death.

(v) Mobile Crane Supported Platform Assisted Rescue: Rescue by use of a personnel platform attached to mobile crane. Another means to perform an assisted rescue is with a personnel platform suspended by a crane using the following guidelines:
- The crane operator must be trained to perform crane operations using a personnel platform for rescue of a fallen worker.
- The employer and the crane operator must ensure that the crane, the personnel platform, and fall protection required is in accordance with OSHA Crane Standard in 29 CFR 1926.1431.
- If the employer anticipates the possible need to use a personnel platform suspended by a crane to rescue a potential fall victim, the crane operator and the rescue team will perform a trial lift prior to worker exposure to a fall hazard. All rescue equipment and the personnel platform must be in the ready position to be attached and suspended by the crane to perform the rescue in a timely manner.
(vi) **Crane as an Anchorage Point:** Anchoring to the load line of a crane. When using the load line of a crane as an anchorage point ensure compliance with OSHA Standard 29 CFR 1926.1423(g), (j) and (k) is mandatory. Personal fall arrest system or rescue equipment for fall arrest is permitted to be anchored to the crane/derrick's hook (or other part of the load line) where all of the following requirements are met:

- A qualified person has determined that the set-up and rated capacity of the crane/derrick (including the hook, load line and rigging) meets or exceeds the requirements of a 5,000 lbs. (22.2 kN) anchorage point per employee attached. If one rescue worker and one employee to be rescued are secured to the hook, load line or rigging than the rated capacity for the crane at the radius and angle of the boom must exceed 10,000 lbs. (44.4 kN) on the load chart for the crane.
- The crane operator must be at the work site and informed that the equipment is being used as an anchorage point for fall protection or for fall rescue equipment.
- No load is suspended from the load line when the personal fall arrest system is anchored to the crane/derrick's hook (or other part of the load line).

**Training.** The employer must train each employee who may be exposed to fall hazards while on, or hoisted by, equipment covered by OSHA's crane standard on all of the following: The requirements of this rescue plan and OSHA's fall protection standard.
(f) ANCHORAGE POINTS (ANSI/ASSE Z359.2 Section 5.4):

<table>
<thead>
<tr>
<th>Strict Load Requirements</th>
<th>Non-Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
<td></td>
</tr>
</tbody>
</table>

(g) ASSEMBLY, MAINTENANCE, INSPECTION, DISASSEMBLY PROCEDURES

Assembly and disassembly of all rescue and equipment will be done according to manufacturers’ recommended procedures. A copy of the manufacturer’s product manuals for each type of rescue and fall equipment used will be on-site.

A site specific list of rescue and fall equipment used on this job will be developed by site management. Rescue personnel will conduct a visual inspection of all rescue and fall protection equipment daily or before each use. Any defective rescue and fall protection equipment will be tagged and removed from service immediately. The manufacturer’s recommendations for maintenance and inspection will be followed.

(h) FALL PROTECTION ENFORCEMENT/DISCIPLINARY POLICY

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand if they knowingly violate the company’s policy they will be terminated. Employees must understand if they knowing violate the company’s policy of fall protection they will be terminated as well. The company’s enforcement and disciplinary policy should address actions that will be taken against sub-contractors as well. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company’s fall protection policy or retraining with a written counseling statement.

(i) REFERENCES TO ANSI / ASSE Z359 FAMILY OF CONSENSUS STANDARDS

The following five ANSI/ASSE Z359 series of consensus standards provides for a “systems approach” to implementation of a fall protection program:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z359.0</td>
<td>Definitions and Nomenclature Used for Fall Protection and Fall Arrest</td>
</tr>
<tr>
<td>Z359.1</td>
<td>Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components</td>
</tr>
<tr>
<td>Z359.2</td>
<td>Minimum Requirements for a Comprehensive Managed Fall Protection Program</td>
</tr>
<tr>
<td>Z359.3</td>
<td>Safety Requirements for Positioning and Travel Restraint Systems</td>
</tr>
<tr>
<td>Z359.4</td>
<td>Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components</td>
</tr>
</tbody>
</table>

(j) AUTHORIZATION:

Signature:  
Date:  
Name:  
Title:  

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.
Sample Rescue Plan

IMPORTANT: This document is intended to provide guidance only for developing site-specific working at heights rescue plans for bridge contractors.

Date: _______ Job Description: ____________________________________________

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>*Method of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated Competent Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Rescue Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Rescuer(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Contact(s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Denotes: Verbal (Face-to-face), Radio Channel (specify channel), phone number or other forms of communication.

Onsite Rescue Equipment (indicate a yes or no for each box)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Yes/No</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rescue Pole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rescue Rope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane as Anchorage Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane with a Personnel Platform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scaffold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerial Work Platform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Rescue &amp; Escape System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Retractable Lifeline</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pre-Planning for Rescue and Fall Protection Equipment

<table>
<thead>
<tr>
<th>#</th>
<th>Yes/No</th>
<th>Rescue and Fall Protection Planning</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Have alternatives to using fall arrest equipment been considered?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Has rescue equipment been inspected and found in serviceable condition?</td>
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<tr>
<td></td>
<td></td>
<td>Is equipment adequate for the rescue plan?</td>
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<tr>
<td></td>
<td></td>
<td>Have communications devices been identified, located, and tested?</td>
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<tr>
<td></td>
<td></td>
<td>Are all rescuers familiar with the use of the rescue equipment?</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>If working over water, is there a skiff and life rings?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Are PFDs worn by worker when working over water?</td>
<td></td>
</tr>
</tbody>
</table>

Describe tasks to be done prior to work to prevent a fall and the step-by-step process to be followed in the event of a fall.

Pre-Work Tasks and Response Procedures

<table>
<thead>
<tr>
<th>#</th>
<th>Pre-Work Task</th>
<th>Response Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AHA (Activity Hazard Analysis) and/or JSA (Job Safety Analysis) has been developed for this task</td>
<td>Call 911</td>
</tr>
<tr>
<td>2</td>
<td>Perform trial test of rescue equipment</td>
<td>Notify Emergency Fall Rescue Team</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Notify First Aid/CPR Personnel</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Notify Site Management</td>
</tr>
<tr>
<td>5</td>
<td></td>
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<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ARTBA Work Zone Safety Consortium

American Road and Transportation Builders Association
National Asphalt Pavement Association
International Union of Operating Engineers
Community College Consortium For Health and Safety Training

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# Employee Fall Protection Training Record

**COMPANY NAME:**

This company has a written fall protection program that details its responsibilities under Occupational Safety and Health Administration (OSHA) fall protection requirements: 29 CFR 1926 Subparts E (Personal Protective Equipment 1926.105 - 106), L (Scaffolding 1926.450 - 454 and Appendices A - E), M (Fall Protection 1926.500-503 and Appendices A - E), R (Steel Erection 1926.760 - 761 and Appendices D and G) and CC (Cranes and Derricks 1926.1423). All employees will be trained by a competent person* who is qualified prior to any job assignment where fall protection is required. The training will enable each employee to recognize fall hazards and to follow appropriate procedures that minimize the hazards. This record certifies the following employees have been trained to recognize fall hazards and to use appropriate fall protection systems and methods to minimize exposure to the hazards, as required in 1926.503(b).

**Employee Name:**

---

## FALL PROTECTION EQUIPMENT COVERED IN TRAINING

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature* (see page 2)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Shock-Absorbing Lanyard</td>
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<tr>
<td>Work Positioning Lanyard</td>
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<tr>
<td>Self-Retracting Lifeline (SRL)</td>
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<tr>
<td>Restraint Line</td>
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<tr>
<td>Horizontal Lifeline</td>
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<tr>
<td>Vertical Lifeline</td>
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<tr>
<td>Incline Line</td>
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<tr>
<td>Rope Grab</td>
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<tr>
<td>Deceleration Device</td>
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<td></td>
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</tr>
<tr>
<td>Locking Snap Hooks</td>
<td></td>
<td></td>
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<tr>
<td>Locking Carabiners</td>
<td></td>
<td></td>
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<tr>
<td>Controlled Descent/ Self-Rescue</td>
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</tr>
</tbody>
</table>

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### FALL PROTECTION EQUIPMENT COVERED IN TRAINING (continued)

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Straps</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Anchorage</td>
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<td></td>
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<tr>
<td>Safety Nets</td>
<td></td>
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<tr>
<td>FP on Aerial Work Platforms (AWP)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>FP on Crane-Supported Personnel Platforms</td>
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<tr>
<td>Other:</td>
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<tr>
<td>Other:</td>
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</tbody>
</table>

**Warning Access Zones and Safety Monitors:** For leading edge work [29 CFR 1926.501(b)(2)] and precast concrete [29 CFR 1926.501(b)(12)] work where the employer can demonstrate that it is infeasible or creates a greater hazard to utilize conventional fall protection equipment, the employer may decide to use controlled access zones and safety monitors. The OSHA position is that it is feasible and the employer has the burden to provide proof that it is infeasible and to prepare a site specific plan in accordance with 29 CFR 1926.502(k). The ARTBA position is that the conventional fall protection is feasible in these activities.

### OSHA STANDARD / COMPANY PROGRAM COVERED IN TRAINING

<table>
<thead>
<tr>
<th>OSHA Standard / Company Program Covered in Training</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company's Written Fall Protection Program</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Company's Written Fall Protection Rescue Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trained to Perform Rescue of Fallen Worker Suspended by Fall Arrest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart E (Safety Nets) 29 CFR 1926.105</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart E (Working Over Water) 29 CFR 1926.106</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Subpart L (Scaffolds/Aerial Lifts) 29 CFR 1926.450-454 and Appendix A - E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart M (Fall Protection) 29 CFR 1926.500-503 Appendix B - E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart R (Steel Erection) 29 CFR 1926.750 - 761 and Appendix A - H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart CC (Crane Standard) 29 CFR 1926.1423 and 1431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* I certify that I have trained the employee/worker for the equipment, company programs and/or OSHA standards listed above. I also certify that I am a competent person who is qualified to provide this training. A Competent Person is one who is capable of identifying existing and predictable hazards [OSHA 29 CFR 1926.32(f)]; authorized to take prompt corrective measures to eliminate hazards [OSHA 29 CFR 1926.32(f)]; and qualified to train employees in all aspects of fall protection covered in OSHA Subpart M [29 CFR 1926.503 (Subpart M)].
This template is intended to aid bridge contractors in developing an overall fall protection plan that includes use of conventional fall protection systems (guardrails, personal fall arrest, personal fall restraint, safety nets, and/or work positioning devices). Such an overall plan can then be adapted for specific work sites. The written plan tells how to control each fall hazard. It lists the fall protection measures to be used, how they are to be used, and who is responsible for supervision and training.

If a bridge contractor wishes to declare an exception to the use of conventional fall protection, Occupational Safety and Health Administration (OSHA) regulation requires a site-specific fall protection plan for using alternative fall protection methods. Such an exception can be made only when the contractor demonstrates that use of conventional systems is not feasible and/or will create a greater hazard. OSHA and the Occupational Safety and Health Review Commission (OSHRC) have placed the burden of establishing ‘infeasibility’ and ‘greater hazard’ claims on the employer. When contractors declare an exception, they must implement a written site-specific fall protection plan which complies with 29 CFR 1926.502(k), in lieu of implementing conventional fall protection.

Bridge contractors can declare an exception to use of conventional fall protection equipment only for leading edge work and precast concrete work. The ARTBA position is that conventional fall protection equipment is feasible and that implementation of the use of conventional fall protection systems will not create a greater hazard.

**THIS BRIDGE FALL PROTECTION PLAN WILL BE AVAILABLE ON THE JOBSITE FOR INSPECTION**

All employees who will be working on this job site will be made aware of the fall hazards and will understand the means to prevent falls and to minimize the injury or death potential of a fall. All employees will be informed of the company policy of enforcement and discipline for this plan. All employees will also be aware of the employer’s rescue plan in the event of a fall.

(a) Site-Specific Job Information:

<table>
<thead>
<tr>
<th>Company Name:</th>
<th>Date of Plan:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Site Location:</td>
<td></td>
</tr>
<tr>
<td>Site Superintendent:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Site Foreman:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Designated Qualified Person:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Designated Competent Person:</td>
<td>Cell/Radio Channel:</td>
</tr>
<tr>
<td>Employees Authorized To Use Fall Protection Equipment:</td>
<td></td>
</tr>
</tbody>
</table>

Cell/Radio Channel: | |

Cell/Radio Channel: |

Cell/Radio Channel: |

Cell/Radio Channel: |

Cell/Radio Channel: |

Cell/Radio Channel: |
(b) Specific Fall Hazards Associated with the Bridge Work Area:

Include locations and dimensions for the hazards, such as but not limited to openings, leading edge work, deck perimeters, bridge structural members, etc. Work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, etc.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

(c) Method of Personal Fall Arrest (PFAS) or Personal Fall Restraint (PFRS):

For all PFAS or PFRS equipment, include the type of equipment, manufacturer's name, and the model number.

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock-Absorbing Lanyard</td>
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<td>Work Positioning Lanyard</td>
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<td>Self-Retracting Lifeline (SRL)</td>
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<tr>
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<tr>
<td>Rope Grab</td>
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<tr>
<td>Deceleration Device</td>
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<tr>
<td>Locking Snap Hooks</td>
<td></td>
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<tr>
<td>Locking Carabiners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled Descent/ Self-Rescue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Equipment</td>
<td>Manufacturer</td>
<td>Model#</td>
</tr>
<tr>
<td>Relief Straps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchorage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Nets</td>
<td></td>
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<tr>
<td>Other:</td>
<td></td>
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<tr>
<td>Other:</td>
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<td>Other:</td>
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</tr>
</tbody>
</table>
(c) Method of Personal Fall Arrest or Personal Fall Restraint (cont.):

Anchorage points: according to ANSI/ASSE Z359.2 Section 5.4

<table>
<thead>
<tr>
<th>Static Load Requirements</th>
<th>Non-Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2 kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td></td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
</tr>
</tbody>
</table>

(d) Assembly, Maintenance, Inspection, Disassembly Procedure for Personal Fall Arrest or Personal Fall Restraint:

Assembly and disassembly of all personal fall arrest, personal fall restraint, work positioning systems, horizontal lifelines, and rescue systems will be done according to manufacturers’ recommended procedures. The specific types of equipment to be used on this job are listed in paragraph (c) on page 2. A copy of the manufacturer’s product manual for each type of fall protection equipment and fall protection system used will be onsite.

A visual inspection of all equipment will be done before each use. The manufacturer’s recommendations for maintenance and inspection will be followed. Any defective equipment will be tagged and removed from service immediately. (A competent person must inspect the jobsite, materials, and equipment on a frequent/regular basis [OSHA Subpart C 1926.20].) Employees responsible for inspection are listed below:

<table>
<thead>
<tr>
<th>Employee Name:</th>
<th>Cell/Radio Channel:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

(e) Handling, Storage and Securing of Tools and Material:

All materials, equipment, and tools not in use while aloft shall be secured against accidental displacement. Include locations and dimensions for the specific hazards.
Fall Protection Plan (continued)

(f) Overhead Protection:

OSHA requires hardhats on all job sites with overhead hazards. It is recommended that hardhats be worn on all construction sites whether or not overhead hazards exist. When working aloft, workers will wear chin straps to secure their hardhats from falling off.

Warning signs will be posted to caution of existing hazards whenever they are present. For example, when steel erection, leading edge work, and pre-cast concrete erection activities are being performed above, then warning signs, barricades and/or danger tape shall clearly mark the area to prohibit workers from accidentally entering the area. In some cases, debris nets may be used if a condition warrants additional protection.

Toeboards will be used on scaffolding, personnel platforms, and aerial work platforms. If tools and/or equipment could fall over the toeboard, then additional safety measures such as – but not limited to – the use of screens to keep the tool and/or equipment on the deck of the scaffolding, personnel platform, and/or aerial work platform will be taken.

In addition to materials being hoisted, employees shall be protected from other falling objects. The bridge contractor will prohibit other construction processes below steel erection, leading edge work, and pre-cast concrete erection activities unless overhead protection is provided in addition to hardhats. If the bridge contractor is not the controlling contractor, the bridge contractor will request that the controlling contractor also communicate and enforce prohibited activity below steel erection, leading edge work, and pre-cast concrete erection activities.

(g) Rescue of Suspended or Injured Worker:

Rescue activities will be performed in accordance with the site-specific rescue plan. (A Sample Fall Rescue Plan for Bridge Work and a fact sheet on Preventing Suspension Trauma are available from ARTBA.)

(h) Working Over Water:

OSHA states that fall protection equipment is required when employees are working 6 feet or more over water. When employees are protected by fall protection 100% of the time (guardrails or personal fall arrest), OSHA does not require the use of a personal floatation device (PFD).

When employees are working over or near water and 100% fall protection is not provided, the requirements of 29 CFR 1926.106 also apply. Where a fall hazard exists of 6 feet or greater to the water, employees must be provided a fall protection harness and a PFD. For comfort, the employee should be provided a combination harness/PFD instead of requiring both a harness and a PFD to be worn simultaneously.

When employees work from aerial lifts or platforms suspended by a crane over water, tie-off using PFAS/PFRS may not be required. OSHA states by letter of interpretation that employees are not required to be tied off when working over water in an aerial lift or from a suspended platform. The employer should evaluate on a case-by-case basis whether only a PFD will be utilized over water when working from an aerial lift or suspended by a crane.

When employees work on a high bridge over water, fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA also states a PFD alone is not adequate if there is a potential of striking a structural member during the fall or striking an object in the water. In these cases the employee must be tied off.

When working over or near water, bridge contractors must ensure:

- Employees are provided with a PFD.
- Prior to and after each use, the PFD must be inspected for defects which would alter strength or buoyancy. Defective PFDs will not be used.
- Ring buoys with at least 90 feet of line must be provided and readily available for emergency rescue operations. Distance between ring buoys will not exceed 200 feet.
- At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.
(i) Guardrail Systems:

In general, guardrails are the preferred fall protection system when feasible. Whenever feasible, the company will select and install guardrail systems before resorting to use of personal fall arrest (PFAS) or personal fall restraint. Include locations where use of guardrail systems is feasible and guardrails will be installed.

(j) Safety Nets:

Where feasible, safety nets are an effective fall protection system. Like guardrails, nets require no special effort on the part of workers who are protected by them. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Include locations where use of safety nets is feasible and safety nets will be installed.

(k) Training Program:

An Employee Fall Protection Training Record is available from ARTBA. Company training program requirements for employees who might be exposed to fall hazards will include:

- Trained by a competent person concerning proper use and limitations of fall protection equipment before exposed to a fall hazard.
- Training must be conducted before employees are allowed to be exposed to fall hazards and directed to use fall protection equipment.
- Employees who have rescue duties will be trained from a competent person on how to properly rescue an employee who has had their fall arrested by fall protection equipment.
- Employees will be retrained when the nature of the work, the workplace, or the methods of control or type of fall protection equipment change to such an extent that prior training is no longer adequate.
- Training of employees in proper use of fall protection equipment will include physical demonstrations by trainees. Demonstrations by employees will verify their knowledge, skills, and proper application of fall protection equipment. Trainees will demonstrate how to inspect, anchor, assemble, and use the fall protection and rescue equipment in locations where they work.
Fall Protection Plan (continued)

(k) Training Program (cont.):

- Training shall include at least the following:
  - Nature of fall hazards in the work area and fall hazard recognition.
  - Fall hazard elimination and control methods.
  - Correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used.
  - Use/operation of guardrail systems, PFAS, PFRS, safety net systems, and/or work positioning systems to be used.
  - All standards contained in OSHA 1926 Subpart M and R and other applicable OSHA fall protection and rescue regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards.
  - Requirements of this fall protection plan and rescue plan/procedures.
  - Pre-use equipment procedures.
- Training shall be conducted at least annually to stay current with fall protection and rescue educational requirements.
- The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the training date(s), the signature of the person trained, and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA.)

NOTE: OSHA requires that the trainer must be a competent person who is qualified in the following areas:
- The nature of fall hazards in the work area;
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used;
- The use and operation of guardrail systems, personal fall arrest systems, personal fall restraint systems, safety net systems, work positioning, controlled access zones, and other protection to be used;
- The correct procedures for the handling and storage of equipment and materials and the erection of overhead protection;
- The role of employees in fall protection plans; and
- The standards in 29 CFR 1926 Subpart M and R, and the requirements in ANSI/ASSE Z359 series as noted in paragraph (l) below.

(l) Fall Protection Enforcement and Disciplinary Policy:

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand that they will be terminated if they knowingly violate the company’s policy. Employees must understand if they violate the company’s fall protection policy they will be terminated as well. The company’s enforcement and disciplinary policy should also address actions that will be taken against subcontractors. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company policy or retraining with a written counseling statement.

(m) References to ANSI/ASSE Z359 Family of Consensus Standards:

Five ANSI/ASSE Z359 consensus standards provide a “systems approach” to implementation of a fall protection program.

| Z359.0 | Definitions and Nomenclature Used for Fall Protection and Fall Arrest |
| Z359.1 | Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components |
| Z359.2 | Minimum Requirements for a Comprehensive Managed Fall Protection Program |
| Z359.3 | Safety Requirements for Positioning and Travel Restraint Systems |
| Z359.4 | Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components |

(n) Authorization:

Signature: __________________________ Date: __________
Name: __________________ Title: __________

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.

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National Asphalt Pavement Association  •  Texas A&M Transportation Institute
International Union of Operating Engineers  •  FOF Communications
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Technical Advice

Fall Protection in Bridge Construction, Inspection, and Maintenance

March 2016

Work Zone Safety Consortium

This material is based upon work supported by the Federal Highway Administration Grant Agreement DTFH61-II-H-00029
Preface

The U.S. Department of Transportation, Federal Highway Administration (FHWA) has jurisdiction for roadway bridges and the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) has regulatory authority for safety practices in bridge construction, inspection, maintenance, and repair.

According to the FHWA report *Safety and Health on Bridge Repair, Renovation and Demolition Projects* (Publication Number: FHWA-RD-98-180) Chapter 3, Section 2: Fall Protection, “To protect employees when they are exposed to fall hazards, some form of fall protection must be used. The most common forms of fall protection are guardrails, personal fall arrest systems, hole covers, and safety nets. Any one or all of these forms of fall protection may be used on construction worksites. The current OSHA standards also require that employees receive training regarding fall protection issues, and that the training is documented.”

This document provides technical advice on fall protection requirements, fall protection systems selection, fall protection plans, employee training, training documentation, and fall rescue plans.

Objectives

This document contains a series of fact sheets on key issues in the selection and use of fall protection in bridge construction, inspection, and maintenance.

This document contains the following fact sheets:

- Fall Protection Systems for Bridge Work
- Fall Protection for Bridge Contractors in 4 Main Steps
- Guide to Selecting Fall Protection Systems for Bridge Work
- OSHA Fall Protection Standards Bridge Contractors Must Know
- Selecting PFAS Lanyards and Connectors for Bridge Work
- Advantages of Self Retracting Lifelines for Bridge Work
- Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance
- Preventing Swing Falls in Bridge Work
- Preventing Suspension Trauma
- Fall Arrest Suspension Trauma Medical Emergency Wallet Card
- Sample Fall Rescue Plan for Bridge Work
- Employee Fall Protection Training Record
- Sample Fall Protection Plan for Bridge Work

To obtain printable PDFs of the facts sheets and/or this document, visit [http://www.workzonesafety.org](http://www.workzonesafety.org).

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Fall Protection Systems for Bridge Work

Occupational Safety and Health Administration (OSHA) fall protection regulations provide detailed definitions of conventional fall protection systems. The OSHA regulations apply to any work 6 feet or more above levels to which workers could fall. The OSHA fall protection standards appear in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards. The ARTBA position is that use of conventional fall protection equipment is feasible in bridge work.*

What Is Fall Protection?
Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. Two basic categories of conventional fall protection equipment systems are available for bridge contractors:

- Fall prevention systems that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- Fall arrest systems that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

Fall Prevention Systems
Guardrails are vertical barriers erected to prevent workers falling to a lower level. Guardrails are an engineering control. Guardrails may be cable, metal, plastic, or wood. Guardrail systems for fall protection are usually different from highway guardrails designed to keep vehicles on the road. Guardrails in place on bridges may not meet OSHA requirements.

(a) Existing bridge guardrails may not meet OSHA requirements. This guardrail is too short and lacks toeboards. Photo source: NBC. (b) This existing guardrail appears to meet OSHA requirements. Photo source: BravoFence. (c) When existing guardrails are not adequate or are not in place, then temporary guardrail can be installed. Photo source: J-Safe.

A standard guardrail consists of a top rail, midrail, toeboard, and uprights. The toeboards prevent tools and materials falling off the work area. The top rail must be 39 to 45 inches above the working surface and must withstand at least 200 pounds of force without deflecting to a point less than 39 inches above the working surface. The midrail must be midway between the top rail and the working surface and must withstand 150 pounds of force. The toeboards must be a minimum of 3.5 inches high and withstand 50 pounds of force. Guardrails may include mesh or wire as greater protection from falling objects.

Guardrail systems provide many advantages. Chief among these is that guardrails are a passive fall prevention system, so workers are not required to operate the equipment after it is installed, though regular inspections by a competent person are necessary. In general, guardrails are the preferred fall protection system when feasible.

*Note: This fact sheet covers conventional fall protection as defined by OSHA. 29 CFR 1926.501(b)(2)(i) requires use of guardrail systems, safety nets, or personal fall arrest systems for employees doing leading edge work. Controlled Access Zones (CAZ) are not presented here because CAZ is not conventional fall protection. A CAZ can be used only if a bridge contractor can demonstrate that use of conventional fall protection is infeasible or creates a greater hazard.
**Fall Protection Systems**

**Personal Fall Restraint Systems (PFRS)** prevent users falling any distance. A PFRS acts as a leash and keeps a worker’s center of gravity from reaching a fall hazard. Like a personal fall arrest system (PFAS), a PFRS includes anchorage, a body harness, connectors, and a lanyard or lifeline. PFRS anchor strength requirements are less than PFAS but, due to the likelihood of misuse or mishap, comparable strength is recommended by experts. A PFRS is more difficult to set up and use than is a PFAS. Like PFAS, PFRS is active fall protection because workers must operate it.

*Photo source: OSHA.*

**Fall Arrest Systems**

Safety nets are hung beneath or around work areas to catch workers or debris. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Safety nets have three main parts and three optional parts:

- net mesh
- support cables
- mounting brackets
- outriggers
- cantilever arms
- various adapters

Safety nets are classified as fall arrest because nets catch workers after a fall. Nets do not prevent falling. Unlike PFAS, safety nets do not require workers to actively do anything to make nets work. Therefore, safety nets are called passive fall protection systems.

**Personal fall arrest systems (PFAS)** are designed to catch a worker who has fallen. It must hold the fallen worker safely until rescue. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. A PFAS must limit maximum arresting force to 1,800 pounds. The free fall distance cannot exceed 6 feet. PFAS is an active fall protection system because workers must operate it. Thinking of the PFAS parts as A-B-C-D helps users remember how the system works and the importance of each part in the system. Here are the A-B-C-Ds of PFAS:

**Anchor** is a secure point at which to attach a lifeline, lanyard, deceleration device, and/or rescue equipment. The best body harness, lanyard, and connectors are nothing without proper anchorage. Anchorage must be capable of supporting at least 5,000 pounds per worker.

**Body harness** consists of shoulder straps, shoulder strap retainer, D-ring, waist strap, thigh straps, sub-pelvic support, and adjustment buckles. The straps distribute fall arrest forces over the upper thighs, pelvis, chest, and shoulders. The D-ring (attachment point) is typically located between the shoulder blades.

**Connectors** are usually D-rings, carabiners, and/or locking snaphooks. (See the ARTBA fact sheet Selecting PFAS Lanyards and Connectors for Bridge Work.)

**Descent and rescue** devices are used to retrieve or lower a fallen worker. These devices and the techniques/skills to use them are an essential part of the fall protection program. (See the ARTBA fact sheets Preventing Suspension Trauma and Sample Fall Rescue Plan.)

**Positioning devices** are body belt or body harness systems rigged to allow a worker to be supported on an elevated vertical surface, such as a wall. In construction work, a positioning device may be used only to protect a worker on a vertical work surface. These devices may permit a fall of up to 2 feet, but positioning devices are not designed as fall arrest. Examples of use include concrete form work or installation of reinforcing steel.

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Fall Protection for Bridge Contractors in 4 Main Steps

For the third year in a row, fall protection was #1 on the Occupational Safety and Health Administration (OSHA) Top 10 list of the most cited violations, with 8,241 fall protection citations issued in 2014, according to OSHA. Now, more than ever, all bridge contractors must learn how to implement comprehensive fall protection programs.

Bridge contractors can achieve 100% fall protection by taking four key steps:

- plan
- provide
- train
- enforce/evaluate

Leading Cause of Death

Falls are the leading cause of death in construction. Falls took the lives of 699 construction workers in 2013 alone. The majority of these fatal falls (82%) were falls to a lower level. Of the lower level falls, about 25% were from 10 feet or less while 75% were from heights of 11 feet and higher (with 55% falling between 11-29 feet and 20% falling 30 feet or more).

The following fatalities illustrate the risks for workers on bridges throughout the United States.

- A 45-year old bridge worker fell 70 feet to his death from the Mount Hope Bridge in Connecticut.
- Two bridge workers, ages 53 and 63, fell 90 feet to their deaths from a bridge near Montgomery, Alabama.
- A 34-year old bridge worker fell 60 feet to his death from a bridge across Lake Washington near Seattle.

When bridge contractors implement effective fall protection programs, they increase worker safety and help prevent deaths and permanent injuries. OSHA, in partnership with the National Institute for Occupational Safety and Health (NIOSH) and National Occupational Research Agenda (NORA) – Construction Sector, has been waging a nationwide outreach campaign to raise awareness among workers and employers about common fall hazards in construction.

The campaign focuses on how falls from ladders, scaffolds, bridge structures, and bridge decks can be prevented. Lives can be saved through an important and highly effective 4-step process: plan, provide, train, and enforce/evaluate.

Step 1: Plan

A well-designed fall protection plan written by a qualified person is the first step to reducing risks and saving lives. OSHA mandates that the fall protection plan must be developed by a qualified person with relevant knowledge and training in order to successfully implement an appropriate fall protection program.

A comprehensive bridge fall protection plan developed by a qualified person should include a statement of company
Fall Protection in 4 Steps (continued)

Policy signed by the highest level of management. The company policy must clearly state employee and supervisor responsibilities as well as enforcement measures and appropriate disciplinary actions. The bridge fall protection plan must also be site specific, with a detailed list of fall prevention measures.

The bridge contractor should designate the competent person(s) in writing. The competent person(s) must:

- Be responsible for implementing the fall protection plan
- Have absolute authority over the fall protection plan
- Have unquestioned authority to stop work and correct fall hazards
- Oversee documented inspections where fall protection measures are utilized
- Keep fall protection equipment maintenance records, records of prompt removal of defective equipment, incident reports, accident investigations records, and employee training records
- Prepare to train employees by acquiring or developing a training program

The fall protection plan must include performing a thorough hazard analysis to determine the areas of risk and methods of engineering out the hazards, if possible. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.) Selection of fall protection systems should be made at this stage. Contingency plans and appropriate rescue equipment should be selected. Finally, a method for enforcing the plan and evaluating effectiveness should be developed.

ARTBA’s Fact Sheet Guide to Selecting Fall Protection Systems for Bridge Work provides detailed descriptions of fall protection equipment and a flow chart to aid selection of fall protection in bridge work.

**Step 2: Provide**

To protect employees working at 6 feet or higher above lower levels, employers must provide the correct fall protection equipment for the job. To help prevent falls, employers must also provide the correct types of ladders, scaffolds, and safety gear.

All fall protection systems and scaffold systems must be designed and/or installed under the supervision of a qualified person. OSHA defines a qualified person as one who “…has proven knowledge, skills, experience, education, certification, or professional standing to solve or resolve problems related to the subject matter, the work, or the project.” [29 CFR 1926.32(m)]

**Step 3: Train**

At a minimum, each employee who might be exposed to fall hazards must be trained by a competent person who is qualified in the following areas [29 CFR 1926.503(a)(2)]:

- The nature of fall hazards in the work area
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems
- The use and operation of guardrail systems, personal fall arrest systems, safety net systems, and/or other protections
- The OSHA fall protection standard

ARTBA offers training products and informational documents, including an Employee Fall Protection Training Record, to help bridge contractors deliver and document required fall protection training for employees.

**Step 4: Enforce/Evaluate**

The company fall protection program must contain mechanisms for enforcing requirements and evaluating the effectiveness of the program. Enforcement mechanisms can include discipline within the normal chain of command, for example. Evaluation can include comparison reviews of training records and policy infractions as well as analysis of any accidents that might occur.

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Fall Protection Systems for Bridge Work

OSHA requires bridge contractors to assess all the hazards of each job before work begins. One method for doing this is a Job Hazard Analysis. A Job Hazard Analysis is a systematic method for determining what specific hazards exist or may arise during work and what appropriate actions need to be taken to protect workers. In bridge work, the number one hazard is falls. Therefore, an analysis of fall hazards is essential. The contractor may do this or the contractor may assign the competent person for fall protection to complete the analysis.

Bridge work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, and other activities.

OSHA requires bridge contractors to assess all the hazards of each job before work begins. One method for doing this is a Job Hazard Analysis. A Job Hazard Analysis is a systematic method for determining what specific hazards exist or may arise during work and what appropriate actions need to be taken to protect workers. In bridge work, the number one hazard is falls. Therefore, an analysis of fall hazards is essential. The contractor may do this or the contractor may assign the competent person for fall protection to complete the analysis.

Following the hazard analysis, a site-specific fall protection plan should be developed. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.) The written plan tells how to control each fall hazard. It should list the conventional fall protection measures to be used, how they are to be used, and who is responsible for supervision and training. At this point, the selection of appropriate and effective fall protection systems is a critical activity.

During this process, the contractor and/or the competent person will refer to the hierarchy of hazard controls to assess how the fall hazards will be addressed. In descending order, the hierarchy is:
- substitution (rarely applicable in construction)
- engineering controls, such as guardrail systems
- administrative procedures, such as restricted entry to controlled access zones
- personal protective equipment (PPE), such as a personal fall arrest system (PFAS)

Some fall protection systems are engineering controls. Some are PPE. Some are a combination.

What Is Fall Protection?
Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. (See ARTBA’s Fall Protection Systems for Bridge Work.) Two basic categories of fall protection systems are available for bridge contractors:
- Fall prevention systems that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.
- Fall arrest systems that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

Fall Protection Flow Chart for Bridge Work
The Fall Protection Flow Chart For Bridge Work on the reverse is a decision tool for analyzing fall hazards and fall protection needs for a bridge jobsite. Answering the questions in the chart can aid in the selection of fall protection systems.
Fall Protection Systems for Bridge Work

Selecting Fall Protection (continued)

Fall Protection Flow Chart for Bridge Work

1. Eliminate Fall Hazard
   - Recognize Fall Hazard
   - Investigate Special Circumstances
   - Does a Fall Hazard Exist?
     - Yes → Does Fall Protection Plan Specify Criteria for Fall Hazards?
       - Yes → Document Fall Protection Program
         - Yes → Create Fall Protection Plan
           - Yes → Complete Fall Protection Plan
             - Yes → Duty of Employer, Estimator, Safety Officer, Competent Person

2. Prevent Fall Hazard
   - Apply Control Hierarchy
     - Is Fall Restraint Feasible?
       - Yes → Apply Fall Restraint
         - Yes → Does a Fall Hazard Exist?
           - Yes → Does Fall Protection Plan Specify Criteria for Fall Hazards?
             - Yes → Document Fall Protection Program
               - Yes → Create Fall Protection Plan
                 - Yes → Complete Fall Protection Plan
                   - Yes → Duty of Employer, Estimator, Safety Officer, Competent Person

3. Arrest Fall Hazard
   - Guarding
     - Can You Add:
       - 1) Fall Restraint
         - Yes → Apply Control Hierarchy
           - Yes → Is Fall Restraint Feasible?
             - Yes → Apply Fall Restraint
               - Yes → Does a Fall Hazard Exist?
                 - Yes → Does Fall Protection Plan Specify Criteria for Fall Hazards?
                   - Yes → Document Fall Protection Program
                     - Yes → Create Fall Protection Plan
                       - Yes → Complete Fall Protection Plan
                         - Yes → Duty of Employer, Estimator, Safety Officer, Competent Person

Other Examples?
- Can You Think of construction techniques.
- For example, accelerated construction techniques.
- Can You Add:
  - 1) Fall Restraint
  - 2) Fall Arrest
  - 3) Control Lines
- Can You Add:
  - 1) Fall Arrest
  - 2) Control Lines
- Can You Add:
  - 1) Control Lines

Exposure <6 Ft May Require Fall Control Measures

Ensure Reliability

Can You Add:
- 1) Fall Restraint
- 2) Fall Arrest
- 3) Control Lines

Apply Redundancy

Other Examples?
- Can You Think of construction techniques.
- For example, accelerated construction techniques.
- Can You Add:
  - 1) Fall Restraint
  - 2) Fall Arrest
  - 3) Control Lines

Exposure <6 Ft May Require Fall Control Measures

Ensure Reliability

Can You Add:
- 1) Fall Restraint
- 2) Fall Arrest
- 3) Control Lines

Apply Redundancy
No single standard of the Occupational Safety and Health Administration (OSHA) covers all the fall protection requirements a bridge contractor needs to know. A bridge contractor must be familiar with at least four subparts of OSHA standards. Further, OSHA standards are minimum standards, so knowledge of several standards of the American National Standards Institute (ANSI) covering fall protection is often also required. The table below provides a general overview of the relevant OSHA standards.

### OSHA Fall Protection Standards for Bridge Contractors (29 CFR 1926)

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*Working over water see [WWW.OSHA.GOV](http://www.OSHA.GOV) for letter of interpretation dated September 28, 1999 linked to 1926.106(a).

**Leading edge work requires conventional fall protection, unless the employer can demonstrate it is not feasible. Where the employer determines it is not feasible, a site-specific written plan in accordance with 1926.502(k) must be developed, implemented, and supervised by a competent person.**

***See OSHA’s [WWW.OSHA.GOV](http://www.OSHA.GOV) eTool and Directive CPL 02 01 034 for more detailed information and NIOSH Campaign to Prevent Falls in Construction [WWW.CDC.GOV/NIOSH/](http://www.CDC.GOV/NIOSH/).

### ARTBA Work Zone Safety Consortium

American Road and Transportation Builders Association  
National Asphalt Pavement Association  
International Union of Operating Engineers  
Community College Consortium For Health and Safety Training  
U.S. Department of Transportation Federal Highway Administration  
Texas A&M Transportation Institute  
FOF Communications  
American Association of State Highway and Transportation Officials

This material is based on work supported by the Federal Highway Administration under Grant Agreement No. DTFH61-11-H-00029. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the Federal Highway Administration. This publication does not constitute a national standard, specification, or regulation.
In a personal fall arrest system (PFAS), a lanyard connects a body harness to an anchor or to a horizontal or vertical lifeline. Lanyards are typically made from 3-foot to 6-foot lengths of synthetic webbing or rope, or wire rope, with attached connectors such as snaphooks, carabiners, or other devices. Lanyards may have built-in shock absorbers to reduce the impact of a fall.

Ideally, a personal fall arrest system is designed, tested, and supplied as a complete system. However, it is common practice for PFAS components to be interchanged because some parts wear out more quickly. The employer should realize that not all components are interchangeable. Proper selection of compatible PFAS components is discussed on the reverse.

### Lanyard Length and Total Fall Clearance Distance

Selection of lanyards in bridge work must consider the total fall clearance distance of a potential fall. The total fall clearance distance is the vertical distance from the anchor to the nearest lower obstruction that a falling worker would impact, such as a structural member or the ground. Five basic factors make up this distance: 1) lanyard length, 2) deceleration distance of the energy absorber in a shock-absorbing lanyard or a shock-pack lanyard, 3) estimated materials stretch, 4) estimated D-ring movement, and 5) height of the suspended worker.

The illustration at left shows how these factors affect total fall clearance distance for a 6-foot worker using a 6-foot lanyard anchored overhead. Safely arresting the fall of a 6-foot worker using a 6-foot lanyard requires approximately 17.5 feet of clearance from the anchorage point to the nearest lower obstruction.

In cases where vertical lifelines or horizontal lifelines are used, calculations of total fall clearance distances must also include the slip of the rope grab plus lifeline stretch (vertical lifeline) or the displacement plus stretch of the lifeline (horizontal lifeline).

For anchorage below standing D-ring level, careful calculation and a larger shock-pack are required to control arresting force.

The required total fall clearance distance may be shortened in any setup by using a shorter lanyard (3, 4 and 5-foot lengths) or by using a self-retracting lifeline (SRL).

When selecting a lanyard for use in an aerial work platform (AWP), consult the operator’s manual to determine the recommended lanyard length. It is best to use a lanyard that will restrain the worker on the AWP and will not allow the worker to fall or be catapulted over a guardrail.

### Lanyard Length and Fall Force

Always select the shortest possible lanyard. The longer the lanyard, the longer the fall and the greater the fall forces. Even short falls can generate huge amounts of force. A 200-pound worker falling 10 feet is subject to 8,000 pounds of force on abrupt impact. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. Lanyards must be selected to limit free falls to no more than 6 feet and 1,800 pounds of force [CFR 1926.502(d)(16)(ii)].

**Example Calculation of Total Fall Clearance Distance**

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**NOTE:** Occupational Safety and Health Administration Standard 29 CFR 1926.502(d)(16)(iv) limits deceleration distance (B) to 3.5 feet. Source of other values: Introduction To Fall Protection, J. Nigel Ellis, Ph.D., CSP, P.E., CPE. 2012. OSHA Standard 29 CFR 1926.502(d) provides specifications for lanyards and does not directly mention ANSI or ANSI/ASSE consensus standards; however, the following OSHA webpage provides a list of various ANSI and ANSI/ASSE consensus standards relating to falls in the construction industry: https://www.osha.gov/SLTC/fallprotection/construction.html.
Lanyard Specifications

Lanyards must display approval by the American National Standards Institute (ANSI) or the American National Standards Institute/American Society of Safety Engineer’s (ANSI/ASSE). Lanyards meeting the specifications of ANSI A10.32, ANSI/ASSE Z359.1 or ANSI/ASSE Z359.13 are permitted in the construction industry. ANSI/ASSE Z359.1 and Z359.13 are more stringent and more comprehensive than the ANSI A10.32.

Compatiblity of Lanyards and Connectors

Connectors on lanyards – such as snap hooks, carabiners, scaffold hooks, or web loops – should be appropriate for the connection made. While a web loop may be appropriate for wrapping around a beam, a snap hook is more often used to connect to a vertical or horizontal lifeline. Scaffold hooks, due the larger opening, are often a better choice for anchors of convenience, such as rebar. When connecting directly to a lifeline, the connector may be an ascender/descender device.

PFAS components are often not interchangeable, whether from one manufacturer or not. In 29 CFR 1926 Subpart M Appendix C, OSHA reminds employers that they must evaluate the compatibility of all components before they are used to protect employees. Manufacturers issue numerous technical bulletins and educational pamphlets to aid in this evaluation.

In particular, OSHA requires employers to determine whether snaphooks are compatible with the members to which they are connected [29 CFR 1926.502(d)(5) and 1926.502(d)(6)(v)].

Connector Specifications

OSHA, ANSI A10.32 and ANSI/ASSE Z359.1 all require that snaphooks and carabiners be self-closing and self-locking. Opening and releasing snap hooks requires two consecutive deliberate actions to prevent rollout and other accidental openings of the snap hook or carabiner. Both ANSI standards are compliant with OSHA 29 CFR 1926.502 requirements.

All acceptable snap hooks or carabiners have a kilo-Newton (kN) rating engraved into the spine. Since 2007, the newest ANSI standard requires all fall protection hardware to have a minimum 16 kN (3,600 pounds) rating for the gate and 22.5 kN, (5,000 pounds) tensile load (ANSI Z359.1-2007, Section 3.2.1.4.). (A kilo-Newton equals about 225 pounds, which is a force of gravity and not static weight or mass. Force = mass times acceleration.)

Compliant connectors are clearly stamped with strength ratings. Avoid any connectors not so marked. Dealing with reputable manufacturers and distributors helps assure acquisition of compliant connectors.

In addition to kN and/or pounds ratings, the stamp should include: year of manufacture and ID, part number, load rating for major axis, load rating for gate and – for non-integral connectors – the ANSI Z359.1(07). Although OSHA stopped requiring the construction industry to meet ANSI 2007 in 2010, it is industry best practice to follow this standard.

Inspection of Lanyards and Connectors

Personal fall arrest system components must be inspected by the user prior to each use and by a competent person on a regular schedule. Defective components must be removed from service [OSHA 29 CFR 1926.502(d)(21)].
Advantages of Self Retracting Lifelines for Bridge Work

A self-retracting lifeline (SRL) is a deceleration device. The SRL contains a drum-wound line that may be either slowly extracted from or retracted onto the drum under slight tension during normal worker movement. A fall automatically locks the drum and arrests the fall. In some cases, despite higher costs, the SRL provides distinct advantages over a lanyard or lifeline and lanyard combination:

- **Reduced free fall compared with lanyard or lanyard-lifeline.** SRLs require less than two feet to arrest a free fall if the anchorage point is vertically above the worker versus 17.5 feet from an anchorage point for a shock-absorbing lanyard.

- **Reduced risk of impacting ground or other objects during a fall.** SRLs provide lower risk of hitting the ground or any other object at a lower level compared with the greater risk due to longer fall distance with a standard lanyard.

- **Easier rescue.** SRLs provide safer and easier rescue of a fallen worker compared with a standard lanyard. With an SRL, the fallen worker may self-rescue using a self-rescue pulley system attached near the SRL anchorage point. Some SRLs have built-in raise or lower options allowing coworkers to perform rescue with little risk. This must be part of the Rescue Plan. (A **Sample Fall Rescue Plan** is available from ARTBA.)

- **Reduced chance of tangles and trips while working.** SRLs reduce the chances of getting tangled and tripping compared with a standard anyard or lanyard and lifeline because the SRL retracts automatically.

**Limitations**
The horizontal distance for work from the anchor point with an SRL is limited, as it is with a lanyard and standard lifeline. The chart below shows safe maximum horizontal working distances for an SRL. Exceeding the distance shown in the chart may result in a hazardous pendulum swing. ([Preventing Swing Falls](#) is available from ARTBA.)

### Examples

Horizontally, the distance a worker in an SRL can move from the anchor point is limited – as it is with a lanyard and standard lifeline. Evaluate the examples below to see how the chart works.

1. If a worker would like to be able to work 20 feet from the anchor point of the SRL, how high above must the anchor point be placed?
   - Look across the chart horizontally on the horizontal working distance axis to the 20-foot mark. This is the desired horizontal working distance from the anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring on the left (H). In the example to permit 20 feet of horizontal movement, the anchor would have to be at 50 feet above D-Ring height.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will be permitted?
   - In this case find the the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow that point down to the axis for horizontal working distance from anchor point (D). The answer is about 15 feet working distance.

Not all SRLs are created equal! Some use wire rope; others use webbing. The choice is frequently based on the work performed. Some SRLs are small and lightweight, good for light duty jobs or where work takes place near the anchor location. Others are heavier for long-term work and may have retractable lines up to 100 feet or more in length. Some can switch between fall restraint or fall arrest modes, and some have built-in automatic rescue options, which are more protective and expensive. Some SRLs are designed for leading edge work where a wire rope or web can pass over a sharp angle or edge, or when workers must anchor near their feet. In every case workers must know the limitations of their SRLs. Several of the important SRL selection and use considerations appear on page 2.
Important SLR Selection and Use Considerations

In bridgework SRLs may be used for leading edge work or where anchorage ends up near the worker’s feet. These circumstances result in additional hazards addressed only by SRLs rated for leading edge work. These hazards, listed below, have resulted in the American National Standards Institute (ANSI) August 2012 Standard Z359.14 on Self Retracting Devices (SRDs).

- **Increased Fall Distance**: When workers are attached at foot level, as they often are in leading edge applications, they will fall farther than they would if they were anchored at shoulder height or above. The required clearance when anchored at foot level varies by product. Therefore, contractors must follow the manufacturer’s instructions.

- **Lock-Up Speed**: Self-retracting lifelines react to a fall when the line accelerates out of the housing at a certain velocity, generally about 4.5 feet per second. When self-retracting lifelines are anchored at foot level, the lifeline does not achieve the required acceleration during a fall until after the user’s D-ring passes over the leading edge and below the level of the anchor. This means the user has already fallen about 5 feet before the self-retracting lifeline device will engage to arrest the fall.

- **Increased Fall Arrest Forces**: Falling farther means the impact on the body through the fall protection system will potentially be higher when the fall is arrested. This is why many leading edge and sharp edge rated products contain additional energy-absorbing devices.

- **Increased Potential for Swing Hazards**: Depending on a worker’s position when a falls begins, the worker may swing like a pendulum after the fall is arrested. While swinging is a hazard under any circumstances, the danger is compounded if the worker’s lifeline is strung taught over a sharp edge and saws back and forth. (See ARTBA's *Preventing Swing Falls in Bridge Work.*)

Failure to use an SLR rated for leading edge work may result in excess fall forces applied to the worker’s body or to the wire rope or webbing being severed by the edge over which the fall has occurred resulting in serious injury or death.

**Further Considerations**


1. Consideration should be given to the particular work environment. For example, the presence of acids, dirt, moisture, oil, grease, etc., and their effect on the system, should be evaluated. Hot or cold environments may also have an adverse effect on the system. Wire rope should not be used where an electrical hazard is anticipated. ...

2. Where lanyards, connectors, and lifelines are subject to damage by work operations such as welding, chemical cleaning, and sandblasting, the component should be protected, or other securing systems should be used. ...

For example, if hot work of some kind — welding, torch-cutting, or burning — is performed, SRLs lines must meet American Society for Testing and Materials (ASTM F887) Arc Test and OSHA 1926.954(b)(1)(ii) requirements to show material will not burn through when slag hits it. Typically, wire-rope or para-aramid webbing meet these standards. Other synthetic fiber web SRLs can be cut, burned, melted, or otherwise damaged during such operations. In addition to the SRL, remember that workers’ harnesses, slings, or other fall protection webbing may need to be fire-resistant.
Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance

Temporary or permanent horizontal lifelines provide workers with the flexibility to move safely on bridges and/or scaffold structures for inspection, maintenance, and construction activities. But preventing falls through the use of horizontal lifelines requires planning, properly engineered systems, proper fall protection equipment, and hands-on training.

**Horizontal Lifeline (HLL) Concepts**

Temporary and permanent horizontal lifeline systems require user equipment such as a full body harness, a shock-absorbing lanyard, or an anti-ratcheting self-retracting lifeline, to ensure 100% fall protection at all times. The equipment must comply with the Occupational Safety and Health Administration (OSHA) arresting force limitations of 1,800 pounds or less [29CFR1926.502(d)(16)(ii)]. It should be easy to use and comfortable to wear. There are four basic steps to keep in mind when choosing fall protection equipment:

- **Have a qualified person assess the fall hazard:** What kind of work is the crew doing and where are the fall hazards located? Different stages of the bridge inspection, maintenance, and construction may require different forms of fall protection.

- **Plan for falls:** What will happen in the case of a fall? Think about the structures below the crew and their fall clearance. Ensure workers will not strike structures below. Plan for prompt rescue. Both unassisted and assisted rescue measures must be provided [29CFR1926.502(d)(20)]. In addition, employers must be prepared to provide emergency first aid to a fall victim within 3-4 minutes [29 CFR 1926.50(c) and OSHA Letter of Interpretation dated January 16, 2007 to Pro Med Training Center].

- **Select the appropriate equipment for the job:** Think about the level of comfort and mobility needed from the equipment and the work location. Ensure the full body harness is sized properly. The harness must be snug fitting to the body and legs. Ensure the harness is not too tight and the worker has full range of movement. If it is too loose, a worker’s shoulders can come out of the harness in the event of a head first fall. In the event of a fall, if the leg straps are too loose, significant and permanent injuries may happen to worker’s scrotum and testicles.

- **Properly train workers, supervisors, and competent persons:** When using safety products, even the smallest things make a very big difference. Competent persons and workers must be trained in the most effective and quickest ways to make adjustments to fall protection systems. Competent persons and workers must be able to recognize and avoid potential problems [29CFR1926.503(a)(1)]. The competent person has the authority to stop work until hazards are corrected [29CFR1926.32(f)]. The best employer safety programs always allow all employees to call for timeout to evaluate potentially unsafe and unhealthy conditions.

**Installation of Horizontal Lifeline Systems**

Horizontal lifeline systems can be job-built or they can be pre-engineered/commercially available systems with built-in shock absorbers. The shock absorber provides catenary* in the line in order to safely take the arresting forces applied by the worker’s fall. The sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points.

A job-built horizontal lifeline can also be used if properly engineered with the proper size of wire rope and attached to two substantial anchorage points on the job site with enough catenary in the line to ensure an engineered safety factor of two [29CFR1926.502(d)(8)].

Regardless of the horizontal lifeline system, the systems shall be designed, installed, and used under the supervision of a qualified person as defined by OSHA [29CFR1926.32(m)]. ANSI/ASSE Z359.2 Section 5.4 states horizontal lifelines sustain two times the maximum tension in the horizontal line during the fall arrest in the direction applied by lifeline forces.

*NOTE: Catenary means that the line has sag, resulting in the line being limp, not tight between the two connection/anchorage points; in engineering terms, a parabolic curve.
Horizontal Lifeline Systems (continued)

Below is a diagram for a typical pre-engineered/commercially available system with built-in shock absorbers. As discussed, the sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points. This sag, while essential for the operation of the horizontal lifeline system, introduces two factors that must be accounted for in installation and use.

- **Sag increases the fall distance.** The natural sag in a horizontal lifeline (B) increases with the length of system. A 20-foot system may sag only 1 inch or so, but a 100-foot system can have as much as 1 foot of natural sag at its center point. Combined with sag caused by loading in a fall, the total fall distance may vary from 18 feet to 40 feet.

- **Sag impacts the location of the worker after a fall.** Because of the sag, workers who fall on a horizontal lifeline tend to migrate to the center point of the lifeline. This poses two challenges to assure that the worker will not smash into an obstruction while migrating to the low point in the line after a fall and to assure that rescue is possible at all points along the horizontal lifeline.

This fact sheet offers only the briefest introduction to horizontal lifeline systems. Its main purpose is to highlight some of the technical issues involved and to motivate you to look carefully and use qualified persons when setting up such a system.

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What Is a Swing Fall?
If the anchor in a personal fall arrest system (PFAS) is not directly above a worker’s head at 0° at all times, then any fall will include a horizontal direction. The horizontal direction makes the fall a ‘swing fall’ or pendulum fall.

The greater the angle from the anchor to the worker:
- the greater the arc of the swing fall
- the faster the velocity or speed of the swing fall
- the longer the vertical fall (free fall)

As the arc and velocity increase, so does the likelihood of impact with objects in the path of the swing fall.

The maximum arc of a swing fall is typically defined by degrees off center from the anchor, added to both sides of the center line. In practice, the arc of the fall will be somewhat less, because the energy of the horizontal movement, which is greatest when the fall begins, will diminish as the swing fall crosses the point of the overhead anchor (0°).

A swing fall can generate a lot of horizontal impact force. A worker in a swing fall can easily reach 20+ miles per hour in the horizontal direction. (A method for calculating swing fall speed appears on the reverse of this sheet.) A face, shoulder, arm, or back smashing into equipment or a structural member will cause serious harm or death for a worker.

Set Maximum Work Ranges
Swing falls can be minimized by working as directly below the anchor as possible (0° line). To reduce the risk of a swing fall, a company’s fall plan should set up a maximum work range from the anchor point to be calculated and enforced by the competent person. Many PFAS manufacturers recommend no more than 30° and others recommend 22.5° or less.

In the diagram on the left, the 0° line is directly below the anchor. The anchor is 20 feet above the working surface.

The 30° lines define a work range of about 8 feet out from the anchor line (0°). The 22.5° lines define a range of about 6 feet from 0°.

For an anchor lower than 20 feet, the work range shrinks proportionately.

A worker anchored at or near the working surface is at increased risk of a swing fall.

If the anchor is less than 5 feet above the working surface (right), then the safe work range is drastically reduced to 2.5 feet out from the anchor line (0°).

Workers often exceed the maximum safe work range and this increases swing fall momentum and free fall distance.

Source: FOF.
How To Calculate Free Fall Distance and Speed in a Swing Fall

If an employee works more than 30° from the anchor, in a swing fall the line will be much longer than if the worker fell directly at 0°. The farther from 0°, the farther the free fall and the faster the falling worker moves.

- Measure the length of the line from the anchor to the D-ring at 0°. This represents the length of the line if no swing fall condition existed. Call it B. *
- Measure the length of the line from the anchor to the D-ring at the farthest work range along the edge. Call it C.
- Find the difference between B and C. Call this L. L is the vertical distance of the free fall.
- To find the speed, multiply L x 32 x 2 x 2. This is the effect of gravity on a falling object — 32 feet per second per second. Then convert feet per second to miles per hour.

EXAMPLE AT RIGHT:

B (anchor to D-ring at 0°) = 13 feet
C (anchor to maximum) = 22 feet

Horizontal  L  Effect of Gravity  FPS
Speed:  9 x (32 x 2 x 2)  =  1152  =  34 ft per sec

Miles Per  FPS  Sec to Hrs  Mile  Speed
Hour:  (34 x 3600)  / 5280 = 23 MPH

* If you only know B, you can calculate C: Measure the maximum distance on the edge from the 0° position at which the worker will work (A). Use A² + B² = C² to find the maximum length of line in the event of a swing fall. C = √A² + B²

Vertical Free Fall Distance (L) = 9 Feet**
**Exceeds OSHA free fall limit of 6 feet.

How To Set Maximum Work Ranges

The chart on the left is an easy tool for finding the maximum work range for a given anchor height. These examples show how the chart works:

1. For work 20 feet from the overhead anchor point (0°), how high must the anchor point be placed above the D-Ring?
   - Look across the chart horizontally to the 20-foot mark. This is the desired horizontal working distance from anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring at left (H). The anchor point would have to be at 50 feet above the D-Ring.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will the worker have?
   - Find the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow down to the axis for the horizontal working distance from the anchor point (D): about 15 feet.
Preventing Suspension Trauma

Arresting a fall is only the first step in preventing injury or death. Even if the arrest does not cause injury, a fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time. Too often, a worker is saved by a personal fall arrest system (PFAS), only to succumb to suspension trauma while waiting for rescue.

Many safety managers, superintendents, and foremen assume their job is done if they limit total PFAS arresting force to 1,800 pounds and prevent impact injury during a fall. Unfortunately, post-fall suspension trauma and the time needed for rescue are often left out of fall protection plans. For a fallen worker awaiting rescue, suspension trauma can become a life-threatening emergency if not handled properly. Therefore, a fall protection plan should always include a plan for rescue.

What Is Suspension Trauma?
Suspension trauma happens when a fallen worker is suspended in a harness with legs hanging. While arteries near the fronts of the legs continue pumping blood, the harness straps act like tourniquets on the veins in the backs of the legs and prevent used (deoxygenated) blood returning to the heart. If circulation is impeded enough, the heart rate will abruptly slow and reduce oxygen to the brain.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Immediate Steps to Reduce the Risk of Suspension Trauma
The best way to slow progression of suspension trauma is to stand. When a worker stands, the leg muscles must contract, which puts pressure on the veins. This pressure, along with a series of one-way valves within the veins, helps blood return to the heart and reduces the amount of blood pooling in the legs. A fallen worker can stand in one of several ways:

- **Suspension trauma relief straps:** A fallen worker can deploy trauma relief straps, creating a loop that the worker steps into and presses against to stand up. Relief straps are typically packaged in two pouches that attach to each side of a harness.
- **Onsite work equipment:** The onsite rescue team may be able to bring a ladder, an aerial lift, or other equipment for the suspended worker to stand on.
- **Structural member:** The onsite rescue team may be able to pull the suspended worker over to a structural member, a lower level, or the ground.

Planning and Preparation
Everyone who works at heights must be fully trained in fall protection. Training should include PFAS rescue and first aid/CPR.

A specific rescue plan must be developed for each jobsite. The supervisor should assign duties, such as who calls 911 and who performs the rescue. The supervisor should evaluate in advance how onsite work equipment could be used. Employers should also provide specialized equipment:

- suspension trauma relief straps,
- self-rescue devices, and/or
- technical rescue equipment for assisted rescue by trained onsite workers. This may include pulley systems, brake-tube systems, winch systems, controlled descent devices, rope ladders, or other devices.

Relief Straps

Hands-On Training
The Rescue

Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Post-rescue death is caused by the heart’s inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Do not put a rescued worker in a horizontal position – whether conscious or not.

If the rescued worker does not have any apparent injuries from the fall, the worker should be placed in a sitting position with knees close to the chest. The position is often called a ‘W’ position. The fall victim should remain in the ‘W’ position for at least 30 minutes to prevent the oxygen-deprived blood returning to the heart suddenly.

When Emergency Medical Services (EMS) arrive onsite, ensure that they know to treat the rescued worker for possible suspension trauma. Inform them how long the worker was suspended.

Employers must plan for and practice fall rescue. Even if self-rescue is the primary plan, a fallen worker may not be able to perform self-rescue, so all workers using PFAS must be trained and prepared to perform assisted rescue.

A Sample Fall Rescue Plan is available from ARTBA.

Before a Fall

- All personnel should be trained that suspension in an upright condition for longer than 5 minutes can be fatal.
- Workers should be trained to try to move their legs in the harness and try to push against any footholds.
- Workers should receive hands-on training on hanging in a harness and should try to get their legs as high as possible and their heads as close to horizontal as possible.
- Workers should not be permitted to work alone in a harness.
- Workers should have a way to signal for help, such as a whistle.
- The rescue plan and training should ensure that rescue of a fall victim happens in less than 5 minutes.
- Onsite work equipment should be evaluated for potential use in a fall rescue.
- Harnesses should be selected for the specific job application and must consider design, compliance, convenience of use, fit, potential arrest injury, and suspension trauma.

After a Fall

- Suspended workers should try to move their legs in the harness and try to push against any footholds, such as relief staps.
- Suspended workers should try to get their legs as high as possible and their heads as close to horizontal as possible.
- If the worker is suspended upright, emergency measures must be taken to remove the worker from suspension or move the fallen worker into a horizontal posture or at least to a sitting position prior to the rescue.
- Rescuers must be aware that post-rescue death may happen if a victim is moved too rapidly to a horizontal position. Moving a worker too quickly to a horizontal position is likely to allow a large volume of used (deoxygenated) blood to move to the heart, causing cardiac arrest.
- Rescuers must be aware of the first aid measures to prevent suspension trauma.

References

1. Illinois Region VII EMS, Emergency Medical Services, an alliance of six EMS Systems with nearly 5,000 EMS providers. A PowerPoint presentation for EMS responders can be downloaded at http://www.regionviems.com/forms/SCC%20CE%20April%202013.pdf

ARTBA Work Zone Safety Consortium

American Road and Transportation Builders Association • U.S. Department of Transportation Federal Highway Administration
National Asphalt Pavement Association • Texas A&M Transportation Institute
International Union of Operating Engineers • FOF Communications
Community College Consortium For Health and Safety Training • American Association of State Highway and Transportation Officials

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Fall Arrest Suspension Trauma
MEDICAL EMERGENCY CARD
KEEP THIS CARD IN YOUR WALLET FOR USE IN FALL RESCUE

A fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time and treated properly.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Suspension trauma traps deoxygenated blood in the veins of the legs. Do not place a rescued worker in a horizontal position. If there is no apparent injury, place the rescued worker in a sitting position with knees close to the chest. This is called the W position. The worker should remain in this position for at least 30 minutes.

See Emergency Medical Responder advice on the back of this card.
Fall Arrest Suspension Trauma
EMERGENCY MEDICAL SERVICES (EMS) ALERT

A worker experiencing a fall arrested by a Personal Fall Arrest System (PFAS) can die from suspension trauma (orthostatic shock). Fall arrest suspension can trap deoxygenated blood in the veins of the legs.

Post-rescue death is caused by the heart’s inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Do not put a rescued worker in a horizontal position, whether conscious or not.

See OSHA Bulletin on Suspension Trauma
www.osha.gov/dts/hibshb/032404.html

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Sample Fall Rescue Plan for Bridge Work

This document is intended to provide guidance for developing fall rescue plans for bridge contractors. The Occupational Safety and Health Administration’s (OSHA) regulation 29 CFR 1926.502(d)(20) states: “The employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves.” Employers should develop a site specific plan for rescue of workers who have fallen. Bridge contractors can consult American National Safety Institute/American Society of Safety Engineers (ANSI/ASSE) Z359.2 (Minimum Requirements for a Comprehensive Managed Fall Protection Program) for additional information in developing a comprehensive fall protection plan. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.)

(a) PURPOSE:

(1) The purpose of this plan is to establish companywide guidelines for responding to a fall at heights of 6 feet and above. This plan should ensure that the victim’s health risks are minimized during a fall. This plan also addresses the need to recognize the hazards of suspension trauma, how to prevent suspension trauma and how to treat suspension trauma. (A fact sheet on Preventing Suspension Trauma is available from ARTBA.)

(2) The rescue plan shall ensure the rescuer(s) is/are protected by fall protection equipment 100% of time during the rescue attempt and that the rescue is conducted in a safe and professional manner.

(b) APPLICATION:

(1) This plan will apply at all locations where personnel are employed.

(2) The requirements of this plan are to be observed by all personnel involved in working at heights of 6 feet and above or where a fall hazard exists.

(3) This plan shall be reviewed and/or included in any Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) when working at heights of 6 feet and above or where working above hazardous equipment regardless of fall height.

(c) DEFINITIONS:

(1) Rescue Plan – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface and is suspended in a full body harness, to include self-rescue or mechanically aided rescue.

(2) Self Rescue – An act or instance of an employee using their fall protection and rescue equipment to perform a rescue without having to put other workers at risk.

(3) Mechanically Aided Rescue – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface using mechanical means.

(4) Suspension Trauma – The medical effects of immobilization in a vertical position. The medical term is orthostatic incompetence or orthostatic shock.

(d) CONTRACTOR RESPONSIBILITIES:

(1) Employee –
   (i) Trained and familiar with the content of the company’s Fall Protection Plan and policies.
   (ii) Able to understand and evaluate the risks associated with working at heights.
   (iii) Trained and competent in the use of fall protection equipment prior to working at heights.
   (iv) Able to report unsafe conditions and/or behaviors to the Person-In-Charge.
   (v) All employees utilizing fall protection equipment, including the designated competent person, lead rescuer and rescue personnel shall be trained in first aid, cardiopulmonary resuscitation (CPR), and suspension trauma (orthostatic incompetence or orthostatic shock).
(2) Authorized Rescuer –
(i) Trained in rescue techniques by a competent rescuer trainer before exposed to a fall hazard or a potential rescue application.
(ii) Shall be retrained when the nature of the work, the workplace, or the methods of control or rescue change to such an extent that prior training is not adequate.
(iii) Training for authorized rescuers shall include physical demonstrations by trainees on how to inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.
(iv) Training shall include at least the following:
- Fall hazard recognition;
- Fall hazard elimination and control methods;
- Applicable fall protection and rescue OSHA regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards;
- How to use written fall protection and rescue procedures; and
- Pre-use equipment inspection procedures.
(v) Authorized rescuer update training shall be conducted at least annually to stay current with the fall protection and rescue educational requirements.
(vi) Authorized rescuers shall be evaluated by a competent rescuer or competent rescue trainer at least annually to ensure competency of the duties assigned. Hands on performance evaluation will be conducted that covers all equipment that the person is authorized to use.
(vii) The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the date(s) of the training, and the signature of the person who was trained and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA).

(3) Competent Rescuer –
(i) Competent rescuers shall be trained by a competent rescue trainer.
(ii) Training for competent rescuers shall include physical demonstrations by trainees on how to properly select, inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.
(iii) Training shall include use of all types of equipment and systems used in locations where rescues may be required, including pre-use inspection procedures, installation, component compatibility, descent control devices, secondary rescue systems, packaging methods to minimize further injury, dismantling, storage and the common hazards associated with each system and component.
(iv) Competent rescuer training shall include at least the following information:
- Fall hazard elimination and control methods;
- Applicable fall protection and rescue regulations;
- Assessment of fall hazards to determine rescue methods;
- Responsibilities of designated persons under OSHA Standards 29 CFR 1926 Subpart M (Fall Protection) and Subpart R (Steel Erection);
- Detailed inspection and recording of rescue equipment components and systems;
- Rescue systems assessment and determining when a system is unsafe;
- Development of written fall protection rescue procedures; and
- Selection and use of non-certified and certified anchorage points.
- First aid, CPR and recognition and treatment of suspension trauma (Orthostatic Incompetence).
(v) Competent rescue training shall be conducted at least annually.
Sample Fall Rescue Plan for Bridge Work

(e) PROCEDURE:

(1) A rescue plan must be a part of the Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) for any job that is to be performed that requires work at heights at or above 6 feet. In all cases where an employee falls and rescue procedures must be implemented call 911. Ensure that the fire department and Emergency Medical Service (EMS) responders are informed that suspension trauma may be involved with the rescue. Initially after a fall that is arrested by fall protection equipment, the fallen worker may appear to have suffered no injury. Often, internal injuries may not be immediately apparent but may be fatal if not medically treated properly. The rescue plan shall include consideration of the following rescue types and circumstances:

(i) **Self-Rescue:** If the competent person supervising those working at heights makes proper choices in the equipment to be used and the worker uses the equipment properly, then 90% of fallen workers will be able to perform self-rescue which should include:
   - Worker will climb back up to the level from which they fell. The worker will usually use an extension ladder to climb back to the bridge deck or surface from which they have fallen.
   - Worker will return to the bridge deck, ground, or other surface and receive prompt medical care and evaluation.
   - Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(ii) **Assisted Self-Rescue:** Assisted Self-Rescue with mechanically aided hauling/rope system that is manually operated. The goal of the assisted self-rescue is for the fallen worker to perform as much of the rescue as possible with assistance. Therefore, if self-rescue is not possible then the worker must be safely retrieved by the use of an assisted self-rescue system which uses a manual mechanical advantage for a hauling/rope system. The following guidelines should be used during a manual mechanically aided rescue:
   - The static load requirements: The mechanical device may be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
   - The haul line may be swung over or lowered to the worker, who will grab the lifeline hook and secure it to the appropriate body support D-ring. As a general rule it is not recommended snapping two snap hooks from separate fall protection equipment into the same D-ring. The front D-ring may be also be used to attach to the haul line. In self-rescue the front D-ring may give the fallen employee greater control staying away from fixed objects in front of them. Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member, all rescue personnel involved in the rescue and the employee (if capable) must all verify that a secondary fall protection or haul line used with a self-retracting lifeline (SRL) has a positive connection. Verification of positive connection to the haul line may be made by the worker hoisting themselves up where the arrest lanyard or SRL is visibly slack. Once all involved have verified a positive connection to the rescue equipment, the lead member of the rescue team may order releasing the lanyard or self-retracting life line that arrested the worker’s fall.
   - If possible, the fallen worker will raise or lower themselves to the appropriate work platform or ground. If the fallen worker cannot raise or lower themselves, then a member of the rescue team must raise or lower the fallen worker to the platform or ground. After the employee has been rescued from their arrested fall, the employee will receive prompt medical attention for all serious injuries, including treatment for possible suspension trauma. ([Fact sheet on **Preventing Suspension Trauma** is available from ARTBA.)
   - Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(iii) **Mechanically Aid Assisted Rescue:** Rescue with manual mechanically aided hauling/rope system by a rescue team member(s). If the workers injuries prevent them from attaching themselves to the rescue system, both self-rescue and assisted self-rescue are not options, and a fully assisted rescue must be performed.
(e) PROCEDURE (cont.):

- The static load requirements: The mechanical device will be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
- A rescue team member must attach the mechanical device haul line to the fallen worker’s fall arrest system. This can be performed by accessing the worker and attaching to the worker’s harness or use a rescue pole for the attachment. The rescue team could also attach a rescue grab to the lanyard or vertical lifeline.
- The rescue team will raise or lower the fallen worker to the appropriate work platform or ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

(iv) Aerial Work Platform Assisted Rescue: Rescue with mechanically aided aerial work platform. Another means to perform an assisted rescue is with an aerial work platform using the following guidelines:

- At least one rescue worker who has been trained to safely operate the aerial work platform will get into the aerial lift and make sure there is a second fall protection device such as a shock absorbing lanyard or SRL available for the fallen worker who is being rescued.
- The aerial lift will be maneuvered into position and then raised up under the worker to be rescued.
- The rescue worker will attach the second lanyard or SRL from the aerial work platform to the fallen worker to be rescued.
- Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member and all rescue personnel involved in the rescue and the fall victim (if capable) must all verify that a positive connection from the aerial work platform to the fall victims harness. The rescue worker after receiving permission from the lead rescue worker, may disconnect the lanyard or SRL involved in arresting the worker’s fall.
- Lower the worker to the ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal floatation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water and that the employees will not use or be required to use fall protection equipment as well. When working on a high bridge with a significant fall hazard employees should be utilizing fall protection. The fall impact forces to water from a high bridge could be severe enough to cause death.

(v) Mobile Crane Supported Platform Assisted Rescue: Rescue by use of a personnel platform attached to mobile crane. Another means to perform an assisted rescue is with a personnel platform suspended by a crane using the following guidelines:

- The crane operator must be trained to perform crane operations using a personnel platform for rescue of a fallen worker.
- The employer and the crane operator must ensure that the crane, the personnel platform, and fall protection required is in accordance with OSHA Crane Standard in 29 CFR 1926.1431.
- If the employer anticipates the possible need to use a personnel platform suspended by a crane to rescue a potential fall victim, the crane operator and the rescue team will perform a trial lift prior to worker exposure to a fall hazard. All rescue equipment and the personnel platform must be in the ready position to be attached and suspended by the crane to perform the rescue in a timely manner.
NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal flotation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water when working from an aerial lift or suspended by a crane. When working on a high bridge with a fall hazard of 40 feet or more to the water fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA states a PFD alone is not adequate if the height of the potential fall is 40 or more feet or there is a potential of striking a structural member during the fall or striking something floating in the water. In these cases the employee must be tied off.

(vi) **Crane as an Anchorage Point:** Anchoring to the load line of a crane. When using the load line of a crane as an anchorage point ensure compliance with OSHA Standard 29 CFR 1926.1423(g), (j) and (k) is mandatory. Personal fall arrest system or rescue equipment for fall arrest is permitted to be anchored to the crane/derrick's hook (or other part of the load line) where all of the following requirements are met:

- A qualified person has determined that the set-up and rated capacity of the crane/derrick (including the hook, load line and rigging) meets or exceeds the requirements of a 5,000 lbs. (22.2 kN) anchorage point per employee attached. If one rescue worker and one employee to be rescued are secured to the hook, load line or rigging than the rated capacity for the crane at the radius and angle of the boom must exceed 10,000 lbs. (44.4 kN) on the load chart for the crane.
- The crane operator must be at the work site and informed that the equipment is being used as an anchorage point for fall protection or for fall rescue equipment.
- No load is suspended from the load line when the personal fall arrest system is anchored to the crane/derrick's hook (or other part of the load line).
- **Training.** The employer must train each employee who may be exposed to fall hazards while on, or hoisted by, equipment covered by OSHA's crane standard on all of the following: The requirements of this rescue plan and OSHA's fall protection standard.
(f) ANCHORAGE POINTS (ANSI/ASSE Z359.2 Section 5.4):

<table>
<thead>
<tr>
<th>Strict Load Requirements</th>
<th>Non-Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
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<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td></td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
</tr>
</tbody>
</table>

(g) ASSEMBLY, MAINTENANCE, INSPECTION, DISASSEMBLY PROCEDURES

Assembly and disassembly of all rescue and equipment will be done according to manufacturers’ recommended procedures. A copy of the manufacturer’s product manuals for each type of rescue and fall protection equipment used will be on-site.

A site specific list of rescue and fall equipment used on this job will be developed by site management. Rescue personnel will conduct a visual inspection of all rescue and fall protection equipment daily or before each use. Any defective rescue and fall protection equipment will be tagged and removed from service immediately. The manufacturer’s recommendations for maintenance and inspection will be followed.

(h) FALL PROTECTION ENFORCEMENT/DISCIPLINARY POLICY

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand if they knowingly violate the company’s policy they will be terminated. Employees must understand if they knowing violate the company’s policy of fall protection they will be terminated as well. The company’s enforcement and disciplinary policy should address actions that will be taken against sub-contractors as well. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company’s fall protection policy or retraining with a written counseling statement.

(i) REFERENCES TO ANSI / ASSE Z359 FAMILY OF CONSENSUS STANDARDS

The following five ANSI/ASSE Z359 series of consensus standards provides for a “systems approach” to implementation of a fall protection program:

- Z359.0 Definitions and Nomenclature Used for Fall Protection and Fall Arrest
- Z359.1 Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components
- Z359.2 Minimum Requirements for a Comprehensive Managed Fall Protection Program
- Z359.3 Safety Requirements for Positioning and Travel Restraint Systems
- Z359.4 Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components

(j) AUTHORIZATION:

Signature: ____________________________ Date: __________

Name: ____________________________ Title: ____________________________

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.
Sample Rescue Plan

IMPORTANT: This document is intended to provide guidance only for developing site-specific working at heights rescue plans for bridge contractors.

Date: _______ Job Description: ____________________________________________

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>*Method of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated Competent Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Rescue Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Rescuer(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Contact(s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Denotes: Verbal (Face-to-face), Radio Channel (specify channel), phone number or other forms of communication.

Onsite Rescue Equipment (indicate a yes or no for each box)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Yes/No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder</td>
<td></td>
<td>Pulley System</td>
</tr>
<tr>
<td>Rescue Pole</td>
<td></td>
<td>Brake-Tube System</td>
</tr>
<tr>
<td>Rescue Rope</td>
<td></td>
<td>Winch System</td>
</tr>
<tr>
<td>Crane as Anchorage Point</td>
<td></td>
<td>Controlled Descent</td>
</tr>
<tr>
<td>Crane with a Personnel Platform</td>
<td></td>
<td>Rope Ladder</td>
</tr>
<tr>
<td>Scaffold</td>
<td></td>
<td>Skiff</td>
</tr>
<tr>
<td>Aerial Work Platform</td>
<td></td>
<td>Life Ring with 90 feet of rope</td>
</tr>
<tr>
<td>Vertical Rescue &amp; Escape System</td>
<td></td>
<td>First Aid Kit</td>
</tr>
<tr>
<td>Self-Retractable Lifeline</td>
<td></td>
<td>Stokes basket</td>
</tr>
</tbody>
</table>

Pre-Planning for Rescue and Fall Protection Equipment

<table>
<thead>
<tr>
<th>Yes/No</th>
<th>Rescue and Fall Protection Planning</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Have alternatives to using fall arrest equipment been considered?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Has rescue equipment been inspected and found in serviceable condition?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is equipment adequate for the rescue plan?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Have communications devices been identified, located, and tested?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are all rescuers familiar with the use of the rescue equipment?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If working over water, is there a skiff and life rings?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are PFDs worn by worker when working over water?</td>
<td></td>
</tr>
</tbody>
</table>

Describe tasks to be done prior to work to prevent a fall and the step-by-step process to be followed in the event of a fall.

Pre-Work Tasks and Response Procedures

<table>
<thead>
<tr>
<th>#</th>
<th>Pre-Work Task</th>
<th>Response Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AHA (Activity Hazard Analysis) and/or JSA (Job Safety Analysis) has been developed for this task</td>
<td>Call 911</td>
</tr>
<tr>
<td>2</td>
<td>Perform trial test of rescue equipment</td>
<td>Notify Emergency Fall Rescue Team</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Notify First Aid/CPR Personnel</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Notify Site Management</td>
</tr>
</tbody>
</table>
| 5  |                                                                                | 5
| 6  |                                                                                | 6
Employee Fall Protection Training Record

This company has a written fall protection program that details its responsibilities under Occupational Safety and Health Administration (OSHA) fall protection requirements: 29 CFR 1926 Subparts E (Personal Protective Equipment 1926.105 - 106), L (Scaffolding 1926.450 - 454 and Appendices A - E), M (Fall Protection 1926.500-503 and Appendices A - E), R (Steel Erection 1926.760 - 761 and Appendices D and G) and CC (Cranes and Derricks 1926.1423). All employees will be trained by a competent person* who is qualified prior to any job assignment where fall protection is required. The training will enable each employee to recognize fall hazards and to follow appropriate procedures that minimize the hazards. This record certifies the following employees have been trained to recognize fall hazards and to use appropriate fall protection systems and methods to minimize exposure to the hazards, as required in 1926.503(b).

Employee Name: ____________________________________________

FALL PROTECTION EQUIPMENT COVERED IN TRAINING

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature* (see page 2)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock-Absorbing Lanyard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Positioning Lanyard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Retracting Lifeline (SRL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restraint Line</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Lifeline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Lifeline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incline Line</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rope Grab</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceleration Device</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locking Snap Hooks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locking Carabiners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled Descent/ Self-Rescue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* ARTBA Work Zone Safety Consortium
  - Texas A&M Transportation Institute
  - FOF Communications
  - U.S. Department of Transportation Federal Highway Administration
  - International Union of Operating Engineers
  - American Association of State Highway and Transportation Officials
  - American Road and Transportation Builders Association
  - National Asphalt Pavement Association
  - Community College Consortium For Health and Safety Training

This material is based on work supported by the Federal Highway Administration under Grant Agreement No. DTFH61-11-H-00029. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the Federal Highway Administration. This publication does not constitute a national standard, specification, or regulation.
### FALL PROTECTION EQUIPMENT COVERED IN TRAINING (continued)

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Straps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchorage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Nets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FP on Aerial Work Platforms (AWP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FP on Crane-Supported Personnel Platforms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
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<tr>
<td>Other:</td>
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</tr>
</tbody>
</table>

**Warning Access Zones and Safety Monitors:** For leading edge work [29 CFR 1926.501(b)(2)] and precast concrete [29 CFR 1926.501(b)(12)] work where the employer can demonstrate that it is infeasible or creates a greater hazard to utilize conventional fall protection equipment, the employer may decide to use controlled access zones and safety monitors. The OSHA position is that it is feasible and the employer has the burden to provide proof that it is infeasible and to prepare a site specific plan in accordance with 29 CFR 1926.502(k). The ARTBA position is that the conventional fall protection is feasible in these activities.

### OSHA STANDARD / COMPANY PROGRAM COVERED IN TRAINING

<table>
<thead>
<tr>
<th>OSHA Standard / Company Program Covered in Training</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company’s Written Fall Protection Program</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Company’s Written Fall Protection Rescue Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trained to Perform Rescue of Fallen Worker Suspended by Fall Arrest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart E (Safety Nets) 29 CFR 1926.105</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart E (Working Over Water) 29 CFR 1926.106</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart L (Scaffolds/Aerial Lifts) 29 CFR 1926.450-454 and Appendix A - E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart M (Fall Protection) 29 CFR 1926.500-503 Appendix B - E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart R (Steel Erection) 29 CFR 1926.750 - 761 and Appendix A - H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subpart CC (Crane Standard) 29 CFR 1926.1423 and 1431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* I certify that I have trained the employee/worker for the equipment, company programs and/or OSHA standards listed above. I also certify that I am a competent person who is qualified to provide this training. A Competent Person is one who is capable of identifying existing and predictable hazards [OSHA 29 CFR 1926.32(f)]; authorized to take prompt corrective measures to eliminate hazards [OSHA 29 CFR 1926.32(f)]; and qualified to train employees in all aspects of fall protection covered in OSHA Subpart M [29 CFR 1926.503 (Subpart M)].
This template is intended to aid bridge contractors in developing an overall fall protection plan that includes use of conventional fall protection systems (guardrails, personal fall arrest, personal fall restraint, safety nets, and/or work positioning devices). Such an overall plan can then be adapted for specific work sites. The written plan tells how to control each fall hazard. It lists the fall protection measures to be used, how they are to be used, and who is responsible for supervision and training.

If a bridge contractor wishes to declare an exception to the use of conventional fall protection, Occupational Safety and Health Administration (OSHA) regulation requires a site-specific fall protection plan for using alternative fall protection methods. Such an exception can be made only when the contractor demonstrates that use of conventional systems is not feasible and/or will create a greater hazard. OSHA and the Occupational Safety and Health Review Commission (OSHRC) have placed the burden of establishing ‘infeasibility’ and ‘greater hazard’ claims on the employer. When contractors declare an exception, they must implement a written site-specific fall protection plan which complies with 29 CFR 1926.502(k), in lieu of implementing conventional fall protection.

Bridge contractors can declare an exception to use of conventional fall protection equipment only for leading edge work and precast concrete work. The ARTBA position is that conventional fall protection equipment is feasible and that implementation of the use of conventional fall protection systems will not create a greater hazard.

**THIS BRIDGE FALL PROTECTION PLAN WILL BE AVAILABLE ON THE JOBSITE FOR INSPECTION**

All employees who will be working on this job site will be made aware of the fall hazards and will understand the means to prevent falls and to minimize the injury or death potential of a fall. All employees will be informed of the company policy of enforcement and discipline for this plan. All employees will also be aware of the employer’s rescue plan in the event of a fall.

(a) Site-Specific Job Information:

<table>
<thead>
<tr>
<th>Company Name:</th>
<th>Date of Plan:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Job Site Location:</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Site Superintendent:</th>
<th>Cell/Radio Channel:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Site Foreman:</th>
<th>Cell/Radio Channel:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Designated Qualified Person:</th>
<th>Cell/Radio Channel:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Designated Competent Person:</th>
<th>Cell/Radio Channel:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Employees Authorized To Use Fall Protection Equipment:</th>
<th>Cell/Radio Channel:</th>
</tr>
</thead>
</table>

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Page 1 of 6
(b) Specific Fall Hazards Associated with the Bridge Work Area:

Include locations and dimensions for the hazards, such as but not limited to openings, leading edge work, deck perimeters, bridge structural members, etc. Work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, etc.

(c) Method of Personal Fall Arrest (PFAS) or Personal Fall Restraint (PFRS):

For all PFAS or PFRS equipment, include the type of equipment, manufacturer's name, and the model number.

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock-Absorbing Lanyard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Positioning Lanyard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Retracting Lifeline (SRL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restraint Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Lifeline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Lifeline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incline Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rope Grab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceleration Device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locking Snap Hooks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locking Carabiners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled Descent/ Self-Rescue</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Straps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchorage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Nets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
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<td></td>
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<td>Other:</td>
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<td>Other:</td>
<td></td>
<td></td>
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<tr>
<td>Other:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(c) Method of Personal Fall Arrest or Personal Fall Restraint (cont.):

Anchorage points: according to ANSI/ASSE Z359.2 Section 5.4

<table>
<thead>
<tr>
<th></th>
<th>Static Load Requirements</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2 kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
<td></td>
</tr>
</tbody>
</table>

(d) Assembly, Maintenance, Inspection, Disassembly Procedure for Personal Fall Arrest or Personal Fall Restraint:

Assembly and disassembly of all personal fall arrest, personal fall restraint, work positioning systems, horizontal lifelines, and rescue systems will be done according to manufacturers’ recommended procedures. The specific types of equipment to be used on this job are listed in paragraph (c) on page 2. A copy of the manufacturer’s product manual for each type of fall protection equipment and fall protection system used will be onsite.

A visual inspection of all equipment will be done before each use. The manufacturer’s recommendations for maintenance and inspection will be followed. Any defective equipment will be tagged and removed from service immediately. (A competent person must inspect the jobsite, materials, and equipment on a frequent/regular basis [OSHA Subpart C 1926.20].) Employees responsible for inspection are listed below:

<table>
<thead>
<tr>
<th>Employee Name</th>
<th>Cell/Radio Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee Name</td>
<td>Cell/Radio Channel</td>
</tr>
<tr>
<td>Employee Name</td>
<td>Cell/Radio Channel</td>
</tr>
<tr>
<td>Employee Name</td>
<td>Cell/Radio Channel</td>
</tr>
<tr>
<td>Employee Name</td>
<td>Cell/Radio Channel</td>
</tr>
</tbody>
</table>

(e) Handling, Storage and Securing of Tools and Material:

All materials, equipment, and tools not in use while aloft shall be secured against accidental displacement.

Include locations and dimensions for the specific hazards.
(f) Overhead Protection:

OSHA requires hardhats on all job sites with overhead hazards. It is recommended that hardhats be worn on all construction sites whether or not overhead hazards exist. When working aloft, workers will wear chin straps to secure their hardhats from falling off.

Warning signs will be posted to caution of existing hazards whenever they are present. For example, when steel erection, leading edge work, and pre-cast concrete erection activities are being performed above, then warning signs, barricades and/or danger tape shall clearly mark the area to prohibit workers from accidentally entering the area. In some cases, debris nets may be used if a condition warrants additional protection.

Toeboards will be used on scaffolding, personnel platforms, and aerial work platforms. If tools and/or equipment could fall over the toeboard, then additional safety measures such as – but not limited to – the use of screens to keep the tool and/or equipment on the deck of the scaffolding, personnel platform, and/or aerial work platform will be taken.

In addition to materials being hoisted, employees shall be protected from other falling objects. The bridge contractor will prohibit other construction processes below steel erection, leading edge work, and pre-cast concrete erection activities unless overhead protection is provided in addition to hardhats. If the bridge contractor is not the controlling contractor, the bridge contractor will request that the controlling contractor also communicate and enforce prohibited activity below steel erection, leading edge work, and pre-cast concrete erection activities.

(g) Rescue of Suspended or Injured Worker:

Rescue activities will be performed in accordance with the site-specific rescue plan. (A Sample Fall Rescue Plan for Bridge Work and a fact sheet on Preventing Suspension Trauma are available from ARTBA.)

(h) Working Over Water:

OSHA states that fall protection equipment is required when employees are working 6 feet or more over water. When employees are protected by fall protection 100% of the time (guardrails or personal fall arrest), OSHA does not require the use of a personal floatation device (PFD).

When employees are working over or near water and 100% fall protection is not provided, the requirements of 29 CFR 1926.106 also apply. Where a fall hazard exists of 6 feet or greater to the water, employees must be provided a fall protection harness and a PFD. For comfort, the employee should be provided a combination harness/PFD instead of requiring both a harness and a PFD to be worn simultaneously.

When employees work from aerial lifts or platforms suspended by a crane over water, tie-off using PFAS/PFRS may not be required. OSHA states by letter of interpretation that employees are not required to be tied off when working over water in an aerial lift or from a suspended platform. The employer should evaluate on a case-by-case basis whether only a PFD will be utilized over water when working from an aerial lift or suspended by a crane.

When employees work on a high bridge over water, fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA also states a PFD alone is not adequate if there is a potential of striking a structural member during the fall or striking an object in the water. In these cases the employee must be tied off.

When working over or near water, bridge contractors must ensure:
- Employees are provided with a PFD.
- Prior to and after each use, the PFD must be inspected for defects which would alter strength or buoyancy. Defective PFDs will not be used.
- Ring buoys with at least 90 feet of line must be provided and readily available for emergency rescue operations. Distance between ring buoys will not exceed 200 feet.
- At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.
(i) Guardrail Systems:

In general, guardrails are the preferred fall protection system when feasible. Whenever feasible, the company will select and install guardrail systems before resorting to use of personal fall arrest (PFAS) or personal fall restraint. Include locations where use of guardrail systems is feasible and guardrails will be installed.

(j) Safety Nets:

Where feasible, safety nets are an effective fall protection system. Like guardrails, nets require no special effort on the part of workers who are protected by them. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed.

Include locations where use of safety nets is feasible and safety nets will be installed.

(k) Training Program:

An Employee Fall Protection Training Record is available from ARTBA. Company training program requirements for employees who might be exposed to fall hazards will include:

- Trained by a competent person concerning proper use and limitations of fall protection equipment before exposed to a fall hazard.
- Training must be conducted before employees are allowed to be exposed to fall hazards and directed to use fall protection equipment.
- Employees who have rescue duties will be trained from a competent person on how to properly rescue an employee who has had their fall arrested by fall protection equipment.
- Employees will be retrained when the nature of the work, the workplace, or the methods of control or type of fall protection equipment change to such an extent that prior training is no longer adequate.
- Training of employees in proper use of fall protection equipment will include physical demonstrations by trainees. Demonstrations by employees will verify their knowledge, skills, and proper application of fall protection equipment. Trainees will demonstrate how to inspect, anchor, assemble, and use the fall protection and rescue equipment in locations where they work.
(k) Training Program (cont.):

- Training shall include at least the following:
  - Nature of fall hazards in the work area and fall hazard recognition.
  - Fall hazard elimination and control methods.
  - Correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used.
  - Use/operation of guardrail systems, PFAS, PFRS, safety net systems, and/or work positioning systems to be used.
  - All standards contained in OSHA 1926 Subpart M and R and other applicable OSHA fall protection and rescue regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards.
  - Requirements of this fall protection plan and rescue plan/procedures.
  - Pre-use equipment procedures.

- Training shall be conducted at least annually to stay current with fall protection and rescue educational requirements.

- The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the training date(s), the signature of the person trained, and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA.)

NOTE: OSHA requires that the trainer must be a competent person who is qualified in the following areas:
- The nature of fall hazards in the work area;
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used;
- The use and operation of guardrail systems, personal fall arrest systems, personal fall restraint systems, safety net systems, work positioning, controlled access zones, and other protection to be used;
- The correct procedures for the handling and storage of equipment and materials and the erection of overhead protection;
- The role of employees in fall protection plans; and
- The standards in 29 CFR 1926 Subpart M and R, and the requirements in ANSI/ASSE Z359 series as noted in paragraph (l) below.

(l) Fall Protection Enforcement and Disciplinary Policy:

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand that they will be terminated if they knowingly violate the company’s policy. Employees must understand if they violate the company’s fall protection policy they will be terminated as well. The company’s enforcement and disciplinary policy should also address actions that will be taken against subcontractors. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company policy or retraining with a written counseling statement.

(m) References to ANSI/ASSE Z359 Family of Consensus Standards:

Five ANSI/ASSE Z359 consensus standards provide a “systems approach” to implementation of a fall protection program.

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(n) Authorization:

Signature: _____________________________ Date: __________

Name: _____________________________ Title: _____________________________

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.

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Preface

The U.S. Department of Transportation, Federal Highway Administration (FHWA) has jurisdiction for roadway bridges and the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) has regulatory authority for safety practices in bridge construction, inspection, maintenance, and repair.

According to the FHWA report Safety and Health on Bridge Repair, Renovation and Demolition Projects (Publication Number: FHWA-RD-98-180) Chapter 3, Section 2: Fall Protection, “To protect employees when they are exposed to fall hazards, some form of fall protection must be used. The most common forms of fall protection are guardrails, personal fall arrest systems, hole covers, and safety nets. Any one or all of these forms of fall protection may be used on construction worksites. The current OSHA standards also require that employees receive training regarding fall protection issues, and that the training is documented.”

This document provides technical advice on fall protection requirements, fall protection systems selection, fall protection plans, employee training, training documentation, and fall rescue plans.

Objectives

This document contains a series of fact sheets on key issues in the selection and use of fall protection in bridge construction, inspection, and maintenance.

This document contains the following fact sheets:

- Fall Protection Systems for Bridge Work
- Fall Protection for Bridge Contractors in 4 Main Steps
- Guide to Selecting Fall Protection Systems for Bridge Work
- OSHA Fall Protection Standards Bridge Contractors Must Know
- Selecting PFAS Lanyards and Connectors for Bridge Work
- Advantages of Self Retracting Lifelines for Bridge Work
- Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance
- Preventing Swing Falls in Bridge Work
- Preventing Suspension Trauma
- Fall Arrest Suspension Trauma Medical Emergency Wallet Card
- Sample Fall Rescue Plan for Bridge Work
- Employee Fall Protection Training Record
- Sample Fall Protection Plan for Bridge Work

To obtain printable PDFs of the facts sheets and/or this document, visit http://www.workzonesafety.org.

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Fall Protection Systems for Bridge Work

Occupational Safety and Health Administration (OSHA) fall protection regulations provide detailed definitions of conventional fall protection systems. The OSHA regulations apply to any work 6 feet or more above levels to which workers could fall. The OSHA fall protection standards appear in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards. The ARTBA position is that use of conventional fall protection equipment is feasible in bridge work.*

What Is Fall Protection?
Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. Two basic categories of conventional fall protection equipment systems are available for bridge contractors:

- **Fall prevention systems** that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- **Fall arrest systems** that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

Fall Prevention Systems

**Guardrails** are vertical barriers erected to prevent workers falling to a lower level. Guardrails are an engineering control. Guardrails may be cable, metal, plastic, or wood. Guardrail systems for fall protection are usually different from highway guardrails designed to keep vehicles on the road. Guardrails in place on bridges may not meet OSHA requirements.

![Guardrail examples](image)

(a) Existing bridge guardrails may not meet OSHA requirements. This guardrail is too short and lacks toeboards. Photo source: NBC. (b) This existing guardrail appears to meet OSHA requirements. Photo source: BravoFence. (c) When existing guardrails are not adequate or are not in place, then temporary guardrail can be installed. Photo source: J-Safe.

A standard guardrail consists of a top rail, midrail, toeboard, and uprights. The toeboards prevent tools and materials falling off the work area. The top rail must be 39 to 45 inches above the working surface and must withstand at least 200 pounds of force without deflecting to a point less than 39 inches above the working surface. The midrail must be midway between the top rail and the working surface and must withstand 150 pounds of force. The toeboards must be a minimum of 3.5 inches high and withstand 50 pounds of force. Guardrails may include mesh or wire as greater protection from falling objects.

Guardrail systems provide many advantages. Chief among these is that guardrails are a passive fall prevention system, so workers are not required to operate the equipment after it is installed, though regular inspections by a competent person are necessary. In general, guardrails are the preferred fall protection system when feasible.

*Note: This fact sheet covers conventional fall protection as defined by OSHA. 29 CFR 1926.501(b)(2)(i) requires use of guardrail systems, safety nets, or personal fall arrest systems for employees doing leading edge work. Controlled Access Zones (CAZ) are not presented here because CAZ is not conventional fall protection. A CAZ can be used only if a bridge contractor can demonstrate that use of conventional fall protection is infeasible or creates a greater hazard.
Personal Fall Restraint Systems (PFRS) prevent users falling any distance. A PFRS acts as a leash and keeps a worker’s center of gravity from reaching a fall hazard. Like a personal fall arrest system (PFAS), a PFRS includes anchorage, a body harness, connectors, and a lanyard or lifeline. PFRS anchor strength requirements are less than PFAS but, due to the likelihood of misuse or mishap, comparable strength is recommended by experts. A PFRS is more difficult to set up and use than is a PFAS. Like PFAS, PFRS is active fall protection because workers must operate it.

Photo source: OSHA.

Fall Arrest Systems

Safety nets are hung beneath or around work areas to catch workers or debris. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Safety nets have three main parts and three optional parts:

- net mesh
- support cables
- mounting brackets
- outriggers
- cantilever arms
- various adapters

Safety nets are classified as fall arrest because nets catch workers after a fall. Nets do not prevent falling. Unlike PFAS, safety nets do not require workers to actively do anything to make nets work. Therefore, safety nets are called passive fall protection systems.

Personal fall arrest systems (PFAS) are designed to catch a worker who has fallen. It must hold the fallen worker safely until rescue. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. A PFAS must limit maximum arresting force to 1,800 pounds. The free fall distance cannot exceed 6 feet. PFAS is an active fall protection system because workers must operate it. Thinking of the PFAS parts as A-B-C-D helps users remember how the system works and the importance of each part in the system. Here are the A-B-C-Ds of PFAS:

A. Anchor is a secure point at which to attach a lifeline, lanyard, deceleration device, and/or rescue equipment. The best body harness, lanyard, and connectors are nothing without proper anchorage. Anchorage must be capable of supporting at least 5,000 pounds per worker.

B. Body harness consists of shoulder straps, shoulder strap retainer, D-ring, waist strap, thigh straps, sub-pelvic support, and adjustment buckles. The straps distribute fall arrest forces over the upper thighs, pelvis, chest, and shoulders. The D-ring (attachment point) is typically located between the shoulder blades.

C. Connectors are usually D-rings, carabiners, and/or locking snaphooks. (See the ARTBA fact sheet Selecting PFAS Lanyards and Connectors for Bridge Work.)

D. Descent and rescue devices are used to retrieve or lower a fallen worker. These devices and the techniques/skills to use them are an essential part of the fall protection program. (See the ARTBA fact sheets Preventing Suspension Trauma and Sample Fall Rescue Plan.)

Positioning devices are body belt or body harness systems rigged to allow a worker to be supported on an elevated vertical surface, such as a wall. In construction work, a positioning device may be used only to protect a worker on a vertical work surface. These devices may permit a fall of up to 2 feet, but positioning devices are not designed as fall arrest. Examples of use include concrete form work or installation of reinforcing steel.

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Fall Protection for Bridge Contractors in 4 Main Steps

For the third year in a row, fall protection was #1 on the Occupational Safety and Health Administration (OSHA) Top 10 list of the most cited violations, with 8,241 fall protection citations issued in 2014, according to OSHA. Now, more than ever, all bridge contractors must learn how to implement comprehensive fall protection programs.

Bridge contractors can achieve 100% fall protection by taking four key steps:
- plan
- provide
- train
- enforce/evaluate

Leading Cause of Death
Falls are the leading cause of death in construction. Falls took the lives of 699 construction workers in 2013 alone. The majority of these fatal falls (82%) were falls to a lower level. Of the lower level falls, about 25% were from 10 feet or less while 75% were from heights of 11 feet and higher (with 55% falling between 11-29 feet and 20% falling 30 feet or more).

The following fatalities illustrate the risks for workers on bridges throughout the United States.
- A 45-year old bridge worker fell 70 feet to his death from the Mount Hope Bridge in Connecticut.
- Two bridge workers, ages 53 and 63, fell 90 feet to their deaths from a bridge near Montgomery, Alabama.
- A 34-year old bridge worker fell 60 feet to his death from a bridge across Lake Washington near Seattle.

When bridge contractors implement effective fall protection programs, they increase worker safety and help prevent deaths and permanent injuries. OSHA, in partnership with the National Institute for Occupational Safety and Health (NIOSH) and National Occupational Research Agenda (NORA) – Construction Sector, has been waging a nationwide outreach campaign to raise awareness among workers and employers about common fall hazards in construction.

The campaign focuses on how falls from ladders, scaffolds, bridge structures, and bridge decks can be prevented. Lives can be saved through an important and highly effective 4-step process: plan, provide, train, and enforce/evaluate.

Step 1: Plan
A well-designed fall protection plan written by a qualified person is the first step to reducing risks and saving lives. OSHA mandates that the fall protection plan must be developed by a qualified person with relevant knowledge and training in order to successfully implement an appropriate fall protection program.

A comprehensive bridge fall protection plan developed by a qualified person should include a statement of company...
policy signed by the highest level of management. The company policy must clearly state employee and supervisor responsibilities as well as enforcement measures and appropriate disciplinary actions. The bridge fall protection plan must also be site specific, with a detailed list of fall prevention measures.

The bridge contractor should designate the competent person(s) in writing. The competent person(s) must:

- Be responsible for implementing the fall protection plan
- Have absolute authority over the fall protection plan
- Have unquestioned authority to stop work and correct fall hazards
- Oversee documented inspections where fall protection measures are utilized
- Keep fall protection equipment maintenance records, records of prompt removal of defective equipment, incident reports, accident investigations records, and employee training records
- Prepare to train employees by acquiring or developing a training program

The fall protection plan must include performing a thorough hazard analysis to determine the areas of risk and methods of engineering out the hazards, if possible. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.) Selection of fall protection systems should be made at this stage. Contingency plans and appropriate rescue equipment should be selected. Finally, a method for enforcing the plan and evaluating effectiveness should be developed.

ARTBA’s Fact Sheet Guide to Selecting Fall Protection Systems for Bridge Work provides detailed descriptions of fall protection equipment and a flow chart to aid selection of fall protection in bridge work.

**Step 2: Provide**

To protect employees working at 6 feet or higher above lower levels, employers must provide the correct fall protection equipment for the job. To help prevent falls, employers must also provide the correct types of ladders, scaffolds, and safety gear.

All fall protection systems and scaffold systems must be designed and/or installed under the supervision of a qualified person. OSHA defines a qualified person as one who “… has proven knowledge, skills, experience, education, certification, or professional standing to solve or resolve problems related to the subject matter, the work, or the project.” [29 CFR 1926.32(m)]

**Step 3: Train**

At a minimum, each employee who might be exposed to fall hazards must be trained by a competent person who is qualified in the following areas [29 CFR 1926.503(a)(2)]:

- The nature of fall hazards in the work area
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems
- The use and operation of guardrail systems, personal fall arrest systems, safety net systems, and/or other protections
- The OSHA fall protection standard

ARTBA offers training products and informational documents, including an Employee Fall Protection Training Record, to help bridge contractors deliver and document required fall protection training for employees.

**Step 4: Enforce/Evaluate**

The company fall protection program must contain mechanisms for enforcing requirements and evaluating the effectiveness of the program. Enforcement mechanisms can include discipline within the normal chain of command, for example. Evaluation can include comparison reviews of training records and policy infractions as well as analysis of any accidents that might occur.

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Bridge work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, and other activities.

Occupational Safety and Health Administration (OSHA) fall protection regulations apply to any work 6 feet or more above levels to which workers could fall. OSHA fall protection standards are in 29 CFR 1926 Subpart M. A State OSHA may have more protective standards.

**Fall Hazard Analysis**

OSHA requires bridge contractors to assess all the hazards of each job before work begins. One method for doing this is a *Job Hazard Analysis*. A Job Hazard Analysis is a systematic method for determining what specific hazards exist or may arise during work and what appropriate actions need to be taken to protect workers. In bridge work, the number one hazard is falls. Therefore, an analysis of fall hazards is essential. The contractor may do this or the contractor may assign the competent person for fall protection to complete the analysis.

Following the hazard analysis, a site-specific fall protection plan should be developed. (A *Sample Fall Protection Plan for Bridge Work* is available from ARTBA.) The written plan tells how to control each fall hazard. It should list the conventional fall protection measures to be used, how they are to be used, and who is responsible for supervision and training. At this point, the selection of appropriate and effective fall protection systems is a critical activity.

During this process, the contractor and/or the competent person will refer to the hierarchy of hazard controls to assess how the fall hazards will be addressed. In descending order, the hierarchy is:

- substitution (rarely applicable in construction)
- engineering controls, such as guardrail systems
- administrative procedures, such as restricted entry to controlled access zones
- personal protective equipment (PPE), such as a personal fall arrest system (PFAS)

Some fall protection systems are engineering controls. Some are PPE. Some are a combination.

**What Is Fall Protection?**

Fall protection is a broad concept. It is more than equipment systems alone. It includes training, procedures, and rules, as well as equipment systems, all working in combination to protect bridge workers from fall hazards. (See ARTBA's *Fall Protection Systems for Bridge Work.*) Two basic categories of fall protection systems are available for bridge contractors:

- **Fall prevention systems** that keep a fall from happening. The two main types of fall prevention systems in bridge work are guardrails and personal fall restraint systems. In addition to these conventional fall protection equipment systems, other fall prevention benefits may result from the use of accelerated construction techniques such as precast modular concrete road panels and bridge elements. Such techniques reduce fall exposures for bridge workers.

- **Fall arrest systems** that stop a fall after it has happened. The three main types of fall arrest systems in bridge work are safety nets, personal fall arrest systems (PFAS), and work positioning devices.

**Fall Protection Flow Chart for Bridge Work**

The *Fall Protection Flow Chart For Bridge Work* on the reverse is a decision tool for analyzing fall hazards and fall protection needs for a bridge jobsite. Answering the questions in the chart can aid in the selection of fall protection systems.

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Fall Protection Flow Chart for Bridge Work

**Fall Safety Hierarchy**

1. Eliminate Fall Hazard
2. Prevent Fall Hazard
3. Arrest Fall Hazard

**Can the Fall Hazard be Eliminated?**
- Yes
- No

**Is Equipment Inspected?**
- Yes
- No

**Can the equipment be made stronger, more resistant, more durable?**
- Yes
- No

**Can You Think of Other Examples?**
- Yes
- No

**Fall Protection Plan**

- Investigate Special Circumstances
- Does a Fall Exposure Exist?
- Does a Fall Exposure Exist?
- Exposure <6 Ft May Require Fall Control Measures

**FALL SAFETY HIERARCHY**

1. Eliminate Fall Hazard
2. Prevent Fall Hazard
3. Arrest Fall Hazard

**Apply Control Hierarchy**

- Can You Add: 1) Control Lines
- Can You Add: 2) Fall Restraint
- Can You Add: 3) Fall Arrest

**Does a Fall Hazard Exist?**
- Yes
- No

**Recognize Fall Hazard**

- Instruct Workers
- Provide Training
- Provide Site-Specific Orientation

**Does Fall Protection Required?**
- Yes
- No

**Develop Fall Protection Plan**

- Determine Fall Protection Requirements
- Design Fall Protection Plan
- Implement Fall Protection Plan

**Safety Factor**

- Assign Trained Personnel
- Provide Daily Site-Specific Orientation
- Install Fall Protection
- Check Equipment, Installation
- Document lessons in database
- Complete project
- Reevaluate plan daily
OSHA Fall Protection Standards for Bridge Contractors (29 CFR 1926)

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</table>

*Working over water see [WWW.OSHA.GOV](http://WWW.OSHA.GOV) for letter of interpretation dated September 28, 1999 linked to 1926.106(a).
**Leading edge work requires conventional fall protection, unless the employer can demonstrate it is not feasible. Where the employer determines it is not feasible, a site-specific written plan in accordance with 1926.502(k) must be developed, implemented, and supervised by a competent person.
***See OSHA’s [WWW.OSHA.GOV](http://WWW.OSHA.GOV) eTool and Directive CPL 02 01 034 for more detailed information and NIOSH Campaign to Prevent Falls in Construction [WWW.CDC.GOV/NIOSH/](http://WWW.CDC.GOV/NIOSH/)

**ARTBA Work Zone Safety Consortium**

American Road and Transportation Builders Association  U.S. Department of Transportation Federal Highway Administration
National Asphalt Pavement Association  Texas A&M Transportation Institute
International Union of Operating Engineers  FOF Communications
Community College Consortium For Health and Safety Training  American Association of State Highway and Transportation Officials

This material is based on work supported by the Federal Highway Administration under Grant Agreement No. DTFH61-11-H-00029. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the Federal Highway Administration. This publication does not constitute a national standard, specification, or regulation.
In a personal fall arrest system (PFAS), a lanyard connects a body harness to an anchor or to a horizontal or vertical lifeline. Lanyards are typically made from 3-foot to 6-foot lengths of synthetic webbing or rope, or wire rope, with attached connectors such as snap hooks, carabiners, or other devices. Lanyards may have built-in shock absorbers to reduce the impact of a fall. Ideally, a personal fall arrest system is designed, tested, and supplied as a complete system. However, it is common practice for PFAS components to be interchanged because some parts wear out more quickly. The employer should realize that not all components are interchangeable. Proper selection of compatible PFAS components is discussed on the reverse.

### Lanyard Length and Total Fall Clearance Distance

Selection of lanyards in bridge work must consider the **total fall clearance distance** of a potential fall. The total fall clearance distance is the vertical distance from the anchor to the nearest lower obstruction that a falling worker would impact, such as a structural member or the ground. Five basic factors make up this distance: 1) lanyard length, 2) deceleration distance of the energy absorber in a shock-absorbing lanyard or a shock-pack lanyard, 3) estimated materials stretch, 4) estimated D-ring movement, and 5) height of the suspended worker.

The illustration at left shows how these factors affect total fall clearance distance for a 6-foot worker using a 6-foot lanyard anchored overhead. Safely arresting the fall of a 6-foot worker using a 6-foot lanyard requires approximately 17.5 feet of clearance from the anchorage point to the nearest lower obstruction.

In cases where vertical lifelines or horizontal lifelines are used, calculations of total fall clearance distances must also include the slip of the rope grab plus lifeline stretch (vertical lifeline) or the displacement plus stretch of the lifeline (horizontal lifeline).

For anchorage below standing D-ring level, careful calculation and a larger shock-pack are required to control arresting force.

The required total fall clearance distance may be shortened in any setup by using a shorter lanyard (3, 4 and 5-foot lengths) or by using a self-retracting lifeline (SRL).

When selecting a lanyard for use in an aerial work platform (AWP), consult the operator’s manual to determine the recommended lanyard length. It is best to use a lanyard that will restrain the worker on the AWP and will not allow the worker to fall or be catapulted over a guardrail.

### Lanyard Length and Fall Force

Always select the shortest possible lanyard. The longer the lanyard, the longer the fall and the greater the fall forces. Even short falls can generate huge amounts of force. A 200-pound worker falling 10 feet is subject to 8,000 pounds of force on abrupt impact. A properly selected and installed PFAS does not prevent falls but greatly reduces their impact. Lanyards must be selected to limit free falls to no more than 6 feet and 1,800 pounds of force [CFR 1926.502(d)(16)(ii)].

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**NOTE:** Occupational Safety and Health Administration Standard 29 CFR 1926.502(d)(16)(iv) limits deceleration distance (B) to 3.5 feet. Source of other values: Introduction To Fall Protection. J. Nigel Ellis, Ph.D., CSP, P.E., CPE. 2012. OSHA Standard 29 CFR 1926.502(d) provides specifications for lanyards and does not directly mention ANSI or ANSI/ASSE consensus standards; however, the following OSHA webpage provides a list of various ANSI and ANSI/ASSE consensus standards relating to falls in the construction industry: [https://www.osha.gov/SLTC/fallprotection/construction.html](https://www.osha.gov/SLTC/fallprotection/construction.html).
Lanyard Specifications
Lanyards must display approval by the American National Standards Institute (ANSI) or the American National Standards Institute/American Society of Safety Engineer’s (ANSI/ASSE). Lanyards meeting the specifications of ANSI A10.32, ANSI/ASSE Z359.1 or ANSI/ASSE Z359.13 are permitted in the construction industry. ANSI/ASSE Z359.1 and Z359.13 are more stringent and more comprehensive than the ANSI A10.32.

Compatibility of Lanyards and Connectors
Connectors on lanyards – such as snap hooks, carabiners, scaffold hooks, or web loops – should be appropriate for the connection made. While a web loop may be appropriate for wrapping around a beam, a snap hook is more often used to connect to a vertical or horizontal lifeline. Scaffold hooks, due the larger opening, are often a better choice for anchors of convenience, such as rebar. When connecting directly to a lifeline, the connector may be an ascender/descender device.

PFAS components are often not interchangeable, whether from one manufacturer or not. In 29 CFR 1926 Subpart M Appendix C, OSHA reminds employers that they must evaluate the compatibility of all components before they are used to protect employees. Manufacturers issue numerous technical bulletins and educational pamphlets to aid in this evaluation.

In particular, OSHA requires employers to determine whether snaphooks are compatible with the members to which they are connected [29 CFR 1926.502(d)(5) and 1926.502(d)(6)(v)].

Connector Specifications
OSHA, ANSI A10.32 and ANSI/ASSE Z359.1 all require that snaphooks and carabiners be self-closing and self-locking. Opening and releasing snap hooks requires two consecutive deliberate actions to prevent rollout and other accidental openings of the snap hook or carabiner. Both ANSI standards are compliant with OSHA 29 CFR 1926.502 requirements.

All acceptable snap hooks or carabiners have a kilo-Newton (kN) rating engraved into the spine. Since 2007, the newest ANSI standard requires all fall protection hardware to have a minimum 16 kN (3,600 pounds) rating for the gate and 22.5 kN, (5,000 pounds) tensile load (ANSI Z359.1-2007, Section 3.2.1.4.). (A kilo-Newton equals about 225 pounds, which is a force of gravity and not static weight or mass. Force = mass times acceleration.)

Compliant connectors are clearly stamped with strength ratings. Avoid any connectors not so marked. Dealing with reputable manufacturers and distributors helps assure acquisition of compliant connectors.

In addition to kN and/or pounds ratings, the stamp should include: year of manufacture and ID, part number, load rating for major axis, load rating for gate and – for non-integral connectors – the ANSI Z359.1(07). Although OSHA stopped requiring the construction industry to meet ANSI 2007 in 2010, it is industry best practice to follow this standard.

Inspection of Lanyards and Connectors
Personal fall arrest system components must be inspected by the user prior to each use and by a competent person on a regular schedule. Defective components must be removed from service [OSHA 29 CFR 1926.502(d)(21)].
Advantages of Self Retracting Lifelines for Bridge Work

A self-retracting lifeline (SRL) is a deceleration device. The SRL contains a drum-wound line that may be either slowly extracted from or retracted onto the drum under slight tension during normal worker movement. A fall automatically locks the drum and arrests the fall. In some cases, despite higher costs, the SRL provides distinct advantages over a lanyard or lifeline and lanyard combination:

- **Reduced free fall compared with lanyard or lanyard-lifeline.** SRLs require less than two feet to arrest a free fall if the anchorage point is vertically above the worker versus 17.5 feet from an anchorage point for a shock-absorbing lanyard.

- **Reduced risk of impacting ground or other objects during a fall.** SRLs provide lower risk of hitting the ground or any other object at a lower level compared with the greater risk due to longer fall distance with a standard lanyard.

- **Easier rescue.** SRLs provide safer and easier rescue of a fallen worker compared with a standard lanyard. With an SRL, the fallen worker may self-rescue using a self-rescue pulley system attached near the SRL anchorage point. Some SRLs have built-in raise or lower options allowing coworkers to perform rescue with little risk. This must be part of the Rescue Plan. (A Sample Fall Rescue Plan is available from ARTBA.)

- **Reduced chance of tangles and trips while working.** SRLs reduce the chances of getting tangled and tripping compared with a standard anyard or lanyard and lifeline because the SRL retracts automatically.

Limitations

The horizontal distance for work from the anchor point with an SRL is limited, as it is with a lanyard and standard lifeline. The chart below shows safe maximum horizontal working distances for an SRL. Exceeding the distance shown in the chart may result in a hazardous pendulum swing. (Preventing Swing Falls is available from ARTBA.)

**Examples**

Horizontally, the distance a worker in an SRL can move from the anchor point is limited – as it is with a lanyard and standard lifeline. Evaluate the examples below to see how the chart works.

1. If a worker would like to be able to work 20 feet from the anchor point of the SRL, how high above must the anchor point be placed?
   - Look across the chart horizontally on the horizontal working distance axis to the 20-foot mark. This is the desired horizontal working distance from the anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring on the left (H). In the example to permit 20 feet of horizontal movement, the anchor would have to be at 50 feet above D-Ring height.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will be permitted?
   - In this case find the the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow that point down to the axis for horizontal working distance from anchor point (D). The answer is about 15 feet working distance.

Not all SRLs are created equal! Some use wire rope; others use webbing. The choice is frequently based on the work performed. Some SRLs are small and lightweight, good for light duty jobs or where work takes place near the anchor location. Others are heavier for long-term work and may have retractable lines up to 100 feet or more in length. Some can switch between fall restraint or fall arrest modes, and some have built-in automatic rescue options, which are more protective and expensive. Some SRLs are designed for leading edge work where a wire rope or web can pass over a sharp angle or edge, or when workers must anchor near their feet. In every case workers must know the limitations of their SRLs. Several of the important SRL selection and use considerations appear on page 2.
Important SLR Selection and Use Considerations

In bridgework SLRs may be used for leading edge work or where anchorage ends up near the worker’s feet. These circumstances result in additional hazards addressed only by SLRs rated for leading edge work. These hazards, listed below, have resulted in the American National Standards Institute (ANSI) August 2012 Standard Z359.14 on Self Retracting Devices (SRDs).

- **Increased Fall Distance**: When workers are attached at foot level, as they often are in leading edge applications, they will fall farther than they would if they were anchored at shoulder height or above. The required clearance when anchored at foot level varies by product. Therefore, contractors must follow the manufacturer’s instructions.

- **Lock-Up Speed**: Self-retracting lifelines react to a fall when the line accelerates out of the housing at a certain velocity, generally about 4.5 feet per second. When self-retracting lifelines are anchored at foot level, the lifeline does not achieve the required acceleration during a fall until after the user’s D-ring passes over the leading edge and below the level of the anchor. This means the user has already fallen about 5 feet before the self-retracting lifeline device will engage to arrest the fall.

- **Increased Fall Arrest Forces**: Falling farther means the impact on the body through the fall protection system will potentially be higher when the fall is arrested. This is why many leading edge and sharp edge rated products contain additional energy-absorbing devices.

- **Increased Potential for Swing Hazards**: Depending on a worker’s position when a falls begins, the worker may swing like a pendulum after the fall is arrested. While swinging is a hazard under any circumstances, the danger is compounded if the worker’s lifeline is strung taught over a sharp edge and saws back and forth. (See ARTBA’s *Preventing Swing Falls in Bridge Work*.)

Failure to use an SLR rated for leading edge work may result in excess fall forces applied to the worker’s body or to the wire rope or webbing being severed by the edge over which the fall has occurred resulting in serious injury or death.

**Further Considerations**

The Occupational Safety and Health Administration (OSHA) fall protection regulation for construction, CFR 29.1926 Subpart M, contains a non-mandatory Appendix C for use by employers in complying with fall protection requirements of 1926.502(d). Appendix C, Part II (a) provides guidance for “selection and use considerations” that impact SLRs and associated fall protection equipment. (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10925)

1. Consideration should be given to the particular work environment. For example, the presence of acids, dirt, moisture, oil, grease, etc., and their effect on the system, should be evaluated. Hot or cold environments may also have an adverse effect on the system. Wire rope should not be used where an electrical hazard is anticipated. ...

2. Where lanyards, connectors, and lifelines are subject to damage by work operations such as welding, chemical cleaning, and sandblasting, the component should be protected, or other securing systems should be used. ...

For example, if hot work of some kind — welding, torch-cutting, or burning — is performed, SLRs lines must meet American Society for Testing and Materials (ASTM F887) Arc Test and OSHA 1926.954(b)(1)(ii) requirements to show material will not burn through when slag hits it. Typically, wire-rope or para-aramid webbing meet these standards. Other synthetic fiber web SLRs can be cut, burned, melted, or otherwise damaged during such operations. In addition to the SLR, remember that workers’ harnesses, slings, or other fall protection webbing may need to be fire-resistant.
Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance

Temporary or permanent horizontal lifelines provide workers with the flexibility to move safely on bridges and/or scaffold structures for inspection, maintenance, and construction activities. But preventing falls through the use of horizontal lifelines requires planning, properly engineered systems, proper fall protection equipment, and hands-on training.

Horizontal Lifeline (HLL) Concepts

Temporary and permanent horizontal lifeline systems require user equipment such as a full body harness, a shock-absorbing lanyard, or an anti-ratcheting self-retracting lifeline, to ensure 100% fall protection at all times. The equipment must comply with the Occupational Safety and Health Administration (OSHA) arresting force limitations of 1,800 pounds or less [29CFR1926.502(d)(16)(iii)]. It should be easy to use and comfortable to wear. There are four basic steps to keep in mind when choosing fall protection equipment:

• **Have a qualified person assess the fall hazard**: What kind of work is the crew doing and where are the fall hazards located? Different stages of the bridge inspection, maintenance, and construction may require different forms of fall protection.

• **Plan for falls**: What will happen in the case of a fall? Think about the structures below the crew and their fall clearance. Ensure workers will not strike structures below. Plan for prompt rescue. Both unassisted and assisted rescue measures must be provided [29CFR1926.502(d)(20)]. In addition, employers must be prepared to provide emergency first aid to a fall victim within 3-4 minutes [29 CFR 1926.50(c) and OSHA Letter of Interpretation dated January 16, 2007 to Pro Med Training Center].

• **Select the appropriate equipment for the job**: Think about the level of comfort and mobility needed from the equipment and the work location. Ensure the full body harness is sized properly. The harness must be snug fitting to the body and legs. Ensure the harness is not too tight and the worker has full range of movement. If it is too loose, a worker’s shoulders can come out of the harness in the event of a head first fall. In the event of a fall, if the leg straps are too loose, significant and permanent injuries may happen to worker’s scrotum and testicles.

• **Properly train workers, supervisors, and competent persons**: When using safety products, even the smallest things make a very big difference. Competent persons and workers must be trained in the most effective and quickest ways to make adjustments to fall protection systems. Competent persons and workers must be able to recognize and avoid potential problems [29CFR1926.503(a)(1)]. The competent person has the authority to **stop work until hazards are corrected** [29CFR1926.32(f)]. The best employer safety programs always allow all employees to call for timeout to evaluate potentially unsafe and unhealthy conditions.

Installation of Horizontal Lifeline Systems

Horizontal lifeline systems can be job-built or they can be pre-engineered/commercially available systems with built-in shock absorbers. The shock absorber provides catenary* in the line in order to safely take the arresting forces applied by the worker’s fall. The sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points.

A job-built horizontal lifeline can also be used if properly engineered with the proper size of wire rope and attached to two substantial anchorage points on the job site with enough catenary in the line to ensure an engineered safety factor of two [29CFR1926.502(d)(8)].

Regardless of the horizontal lifeline system, the systems shall be designed, installed, and used under the supervision of a qualified person as defined by OSHA [29CFR1926.32(m)]. ANSI/ASSE Z359.2 Section 5.4 states horizontal lifelines sustain two times the maximum tension in the horizontal line during the fall arrest in the direction applied by lifeline forces.

*NOTE: Catenary means that the line has sag, resulting in the line being limp, not tight between the two connection/anchorage points; in engineering terms, a parabolic curve.
Horizontal Lifeline Systems (continued)

Below is a diagram for a typical pre-engineered/commercially available system with built-in shock absorbers. As discussed, the sag in the horizontal lifeline reduces the forces applied to the horizontal lifeline and the connection points. This sag, while essential for the operation of the horizontal lifeline system, introduces two factors that must be accounted for in installation and use.

- **Sag increases the fall distance.** The natural sag in a horizontal lifeline (B) increases with the length of system. A 20-foot system may sag only 1 inch or so, but a 100-foot system can have as much as 1 foot of natural sag at its center point. Combined with sag caused by loading in a fall, the total fall distance may vary from 18 feet to 40 feet.

- **Sag impacts the location of the worker after a fall.** Because of the sag, workers who fall on a horizontal lifeline tend to migrate to the center point of the lifeline. This poses two challenges to assure that the worker will not smash into an obstruction while migrating to the low point in the line after a fall and to assure that rescue is possible at all points along the horizontal lifeline.

This fact sheet offers only the briefest introduction to horizontal lifeline systems. Its main purpose is to highlight some of the technical issues involved and to motivate you to look carefully and use qualified persons when setting up such a system.

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What Is a Swing Fall?

If the anchor in a personal fall arrest system (PFAS) is not directly above a worker’s head at 0° at all times, then any fall will include a horizontal direction. The horizontal direction makes the fall a ‘swing fall’ or pendulum fall.

The greater the angle from the anchor to the worker:
• the greater the arc of the swing fall
• the faster the velocity or speed of the swing fall
• the longer the vertical fall (free fall)

As the arc and velocity increase, so does the likelihood of impact with objects in the path of the swing fall.

The maximum arc of a swing fall is typically defined by degrees off center from the anchor, added to both sides of the center line. In practice, the arc of the fall will be somewhat less, because the energy of the horizontal movement, which is greatest when the fall begins, will diminish as the swing fall crosses the point of the overhead anchor (0°).

A swing fall can generate a lot of horizontal impact force. A worker in a swing fall can easily reach 20+ miles per hour in the horizontal direction. (A method for calculating swing fall speed appears on the reverse of this sheet.) A face, shoulder, arm, or back smashing into equipment or a structural member will cause serious harm or death for a worker.

Set Maximum Work Ranges

Swing falls can be minimized by working as directly below the anchor as possible (0° line). To reduce the risk of a swing fall, a company’s fall plan should set up a maximum work range from the anchor point to be calculated and enforced by the competent person. Many PFAS manufacturers recommend no more than 30° and others recommend 22.5° or less.

In the diagram on the left, the 0° line is directly below the anchor. The anchor is 20 feet above the working surface.

The 30° lines define a work range of about 8 feet out from the anchor line (0°). The 22.5° lines define a range of about 6 feet from 0°.

For an anchor lower than 20 feet, the work range shrinks proportionately.

A worker anchored at or near the working surface is at increased risk of a swing fall.

If the anchor is less than 5 feet above the working surface (right), then the safe work range is drastically reduced to 2.5 feet out from the anchor line (0°).

Workers often exceed the maximum safe work range and this increases swing fall momentum and free fall distance.

Source: FOF.
How To Calculate Free Fall Distance and Speed in a Swing Fall

If an employee works more than 30° from the anchor, in a swing fall the line will be much longer than if the worker fell directly at 0°. The farther from 0°, the farther the free fall and the faster the falling worker moves.

- Measure the length of the line from the anchor to the D-ring at 0°. This represents the length of the line if no swing fall condition existed. Call it B.*
- Measure the length of the line from the anchor to the D-ring at the farthest work range along the edge. Call it C.
- Find the difference between B and C. Call this L. L is the vertical distance of the free fall.
- To find the speed, multiply L x 32 x 2 x 2. This is the effect of gravity on a falling object — 32 feet per second per second. Then convert feet per second to miles per hour.

EXAMPLE AT RIGHT:

<table>
<thead>
<tr>
<th>B (anchor to D-ring at 0°)</th>
<th>C (anchor to maximum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 feet</td>
<td>22 feet</td>
</tr>
</tbody>
</table>

Horizontal Length (L) = 22 feet
Effect of Gravity = (32 x 2 x 2) = 128

Speed Formula: \[ \text{Speed} = \frac{\text{Effect of Gravity} \times 32}{\text{Horizontal Length}} \]

\[ \text{Speed} = \frac{128 \times 32}{22} \approx 179.09 \text{ ft/sec} \]

Convert to mph: \[ \text{Speed} = \frac{179.09 \times 3600}{5280} \approx 115.2 \text{ mph} \]

* If you only know B, you can calculate C:
  Measure the maximum distance on the edge from the 0° position at which the worker will work (A). Use \( A^2 + B^2 = C^2 \) to find the maximum length of line in the event of a swing fall. \( C = \sqrt{A^2 + B^2} \)

Swing Fall Speed = 23 MPH

How To Set Maximum Work Ranges

The chart on the left is an easy tool for finding the maximum work range for a given anchor height. These examples show how the chart works:

1. For work 20 feet from the overhead anchor point (0°), how high must the anchor point be placed above the D-Ring?
   - Look across the chart horizontally to the 20-foot mark. This is the desired horizontal working distance from anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring at left (H). The anchor point would have to be at 50 feet above the D-Ring.

2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will the worker have?
   - Find the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow down to the axis for the horizontal working distance from the anchor point (D): about 15 feet.

**Source: FOF**
Preventing Suspension Trauma

Arresting a fall is only the first step in preventing injury or death. Even if the arrest does not cause injury, a fallen worker can die from suspension trauma (orthostatic shock) if not rescued in time. Too often, a worker is saved by a personal fall arrest system (PFAS), only to succumb to suspension trauma while waiting for rescue.

Many safety managers, superintendents, and foremen assume their job is done if they limit total PFAS arresting force to 1,800 pounds and prevent impact injury during a fall. Unfortunately, post-fall suspension trauma and the time needed for rescue are often left out of fall protection plans. For a fallen worker awaiting rescue, suspension trauma can become a life-threatening emergency if not handled properly. Therefore, a fall protection plan should always include a plan for rescue.

What Is Suspension Trauma?
Suspension trauma happens when a fallen worker is suspended in a harness with legs hanging. While arteries near the fronts of the legs continue pumping blood, the harness straps act like tourniquets on the veins in the backs of the legs and prevent used (deoxygenated) blood returning to the heart. If circulation is impeded enough, the heart rate will abruptly slow and reduce oxygen to the brain.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Immediate Steps to Reduce the Risk of Suspension Trauma
The best way to slow progression of suspension trauma is to stand. When a worker stands, the leg muscles must contract, which puts pressure on the veins. This pressure, along with a series of one-way valves within the veins, helps blood return to the heart and reduces the amount of blood pooling in the legs. A fallen worker can stand in one of several ways:

- **Suspension trauma relief straps:** A fallen worker can deploy trauma relief straps, creating a loop that the worker steps into and presses against to stand up. Relief straps are typically packaged in two pouches that attach to each side of a harness.
- **Onsite work equipment:** The onsite rescue team may be able to bring a ladder, an aerial lift, or other equipment for the suspended worker to stand on.
- **Structural member:** The onsite rescue team may be able to pull the suspended worker over to a structural member, a lower level, or the ground.

Planning and Preparation
Everyone who works at heights must be fully trained in fall protection. Training should include PFAS rescue and first aid/CPR.

A specific rescue plan must be developed for each jobsite. The supervisor should assign duties, such as who calls 911 and who performs the rescue. The supervisor should evaluate in advance how onsite work equipment could be used. Employers should also provide specialized equipment:

- suspension trauma relief straps,
- self-rescue devices, and/or
- technical rescue equipment for assisted rescue by trained onsite workers. This may include pulley systems, brake-tube systems, winch systems, controlled descent devices, rope ladders, or other devices.
The Rescue

Whether or not the suspended worker has lost consciousness, the rescue team must be careful in handling the victim. Post-rescue death is caused by the heart’s inability to tolerate the abruptly increased flow of carbon dioxide-saturated blood from the legs. Do not put a rescued worker in a horizontal position – whether conscious or not.

If the rescued worker does not have any apparent injuries from the fall, the worker should be placed in a sitting position with knees close to the chest. The position is often called a ‘W’ position. The fall victim should remain in the ‘W’ position for at least 30 minutes to prevent the oxygen-deprived blood returning to the heart suddenly.

When Emergency Medical Services (EMS) arrive onsite, ensure that they know to treat the rescued worker for possible suspension trauma. Inform them how long the worker was suspended.

**Employers must plan for and practice fall rescue. Even if self-rescue is the primary plan, a fallen worker may not be able to perform self-rescue, so all workers using PFAS must be trained and prepared to perform assisted rescue.**

A Sample Fall Rescue Plan is available from ARTBA.

Before a Fall

- All personnel should be trained that suspension in an upright condition for longer than 5 minutes can be fatal.
- Workers should be trained to try to move their legs in the harness and try to push against any footholds.
- Workers should receive hands-on training on hanging in a harness and should try to get their legs as high as possible and their heads as close to horizontal as possible.
- Workers should not be permitted to work alone in a harness.
- Workers should have a way to signal for help, such as a whistle.
- The rescue plan and training should ensure that rescue of a fall victim happens in less than 5 minutes.
- Onsite work equipment should be evaluated for potential use in a fall rescue.
- Harnesses should be selected for the specific job application and must consider design, compliance, convenience of use, fit, potential arrest injury, and suspension trauma.

After a Fall

- Suspended workers should try to move their legs in the harness and try to push against any footholds, such as relief staps.
- Suspended workers should try to get their legs as high as possible and their heads as close to horizontal as possible.
- If the worker is suspended upright, emergency measures must be taken to remove the worker from suspension or move the fallen worker into a horizontal posture or at least to a sitting position prior to the rescue.
- Rescuers must be aware that post-rescue death may happen if a victim is moved too rapidly to a horizontal position. Moving a worker too quickly to a horizontal position is likely to allow a large volume of used (deoxygenated) blood to move to the heart, causing cardiac arrest.
- Rescuers must be aware of the first aid measures to prevent suspension trauma.

References
1. Illinois Region VII EMS, Emergency Medical Services, an alliance of six EMS Systems with nearly 5,000 EMS providers. A PowerPoint presentation for EMS responders can be downloaded at http://www.regionviiems.com/forms/SCC%20CE%20April%202013.pdf

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See Emergency Medical Responder advice on the back of this card.

Suspended trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Even under ideal circumstances, with a rescue plan in place, suspension trauma must be treated as an emergency. It can be fatal in as little as 10 minutes. Typically, suspension trauma causes death in 15 to 40 minutes.

Suspected trauma traps deoxygenated blood in the veins of the legs. DO NOT PLACE A RESCUED WORKER IN A HORIZONTAL POSITION. If there is no apparent injury, place the rescued worker in a sitting position with knees close to the chest. This is called the W position. The worker should remain in this position for at least 30 minutes.
Fall Arrest Suspension Trauma
EMERGENCY MEDICAL SERVICES (EMS) ALERT
A worker experiencing a fall arrested by a Personal Fall Arrest System (PFAS) can die from suspension trauma (orthostatic shock). Fall arrest suspension can trap deoxygenated blood in the veins of the legs.

See OSHA Bulletin on Suspension Trauma
www.osha.gov/dts/hib/03/2404.html

American Road & Transportation Builders Association Work Zone Safety Consortium
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This document is intended to provide guidance for developing fall rescue plans for bridge contractors. The Occupational Safety and Health Administration’s (OSHA) regulation 29 CFR 1926.502(d)(20) states: “The employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves.” Employers should develop a site specific plan for rescue of workers who have fallen. Bridge contractors can consult American National Safety Institute/ American Society of Safety Engineers (ANSI/ASSE) Z359.2 (Minimum Requirements for a Comprehensive Managed Fall Protection Program) for additional information in developing a comprehensive fall protection plan. (A Sample Fall Protection Plan for Bridge Work is available from ARTBA.)

(a) PURPOSE:

(1) The purpose of this plan is to establish companywide guidelines for responding to a fall at heights of 6 feet and above. This plan should ensure that the victim’s health risks are minimized during a fall. This plan also addresses the need to recognize the hazards of suspension trauma, how to prevent suspension trauma and how to treat suspension trauma. (A fact sheet on Preventing Suspension Trauma is available from ARTBA.)

(2) The rescue plan shall ensure the rescuer(s) is/are protected by fall protection equipment 100% of time during the rescue attempt and that the rescue is conducted in a safe and professional manner.

(b) APPLICATION:

(1) This plan will apply at all locations where personnel are employed.

(2) The requirements of this plan are to be observed by all personnel involved in working at heights of 6 feet and above or where a fall hazard exists.

(3) This plan shall be reviewed and/or included in any Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) when working at heights of 6 feet and above or where working above hazardous equipment regardless of fall height.

(c) DEFINITIONS:

(1) **Rescue Plan** – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface and is suspended in a full body harness, to include self-rescue or mechanically aided rescue.

(2) **Self Rescue** – An act or instance of an employee using their fall protection and rescue equipment to perform a rescue without having to put other workers at risk.

(3) **Mechanically Aided Rescue** – A strategy or procedure, planned in advance, to retrieve safely a person who has fallen from an elevated work surface using mechanical means.

(4) **Suspension Trauma** – The medical effects of immobilization in a vertical position. The medical term is orthostatic incompetence or orthostatic shock.

(d) **CONTRACTOR RESPONSIBILITIES:**

(1) **Employee** –
   (i) Trained and familiar with the content of the company’s Fall Protection Plan and policies.
   (ii) Able to understand and evaluate the risks associated with working at heights.
   (iii) Trained and competent in the use of fall protection equipment prior to working at heights.
   (iv) Able to report unsafe conditions and/or behaviors to the Person-In-Charge.
   (v) All employees utilizing fall protection equipment, including the designated competent person, lead rescuer and rescue personnel shall be trained in first aid, cardiopulmonary resuscitation (CPR), and suspension trauma (orthostatic incompetence or orthostatic shock).
(d) CONTRACTOR RESPONSIBILITIES (cont.):

(2) Authorized Rescuer –
   (i) Trained in rescue techniques by a competent rescuer trainer before exposed to a fall hazard or a potential rescue application.
   (ii) Shall be retrained when the nature of the work, the workplace, or the methods of control or rescue change to such an extent that prior training is not adequate.
   (iii) Training for authorized rescuers shall include physical demonstrations by trainees on how to inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.
   (iv) Training shall include at least the following:
      - Fall hazard recognition;
      - Fall hazard elimination and control methods;
      - Applicable fall protection and rescue OSHA regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards;
      - How to use written fall protection and rescue procedures; and
      - Pre-use equipment inspection procedures.
   (v) Authorized rescuer update training shall be conducted at least annually to stay current with the fall protection and rescue educational requirements.
   (vi) Authorized rescuers shall be evaluated by a competent rescuer or competent rescue trainer at least annually to ensure competency of the duties assigned. Hands on performance evaluation will be conducted that covers all equipment that the person is authorized to use.
   (vii) The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the date(s) of the training, and the signature of the person who was trained and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA).

(3) Competent Rescuer –
   (i) Competent rescuers shall be trained by a competent rescue trainer.
   (ii) Training for competent rescuers shall include physical demonstrations by trainees on how to properly select, inspect, anchor, assemble and use the fall protection and rescue equipment used in locations where they work.
   (iii) Training shall include use of all types of equipment and systems used in locations where rescues may be required, including pre-use inspection procedures, installation, component compatibility, descent control devices, secondary rescue systems, packaging methods to minimize further injury, dismantling, storage and the common hazards associated with each system and component.
   (iv) Competent rescuer training shall include at least the following information:
      - Fall hazard elimination and control methods;
      - Applicable fall protection and rescue regulations;
      - Assessment of fall hazards to determine rescue methods;
      - Responsibilities of designated persons under OSHA Standards 29 CFR 1926 Subpart M (Fall Protection) and Subpart R (Steel Erection);
      - Detailed inspection and recording of rescue equipment components and systems;
      - Rescue systems assessment and determining when a system is unsafe;
      - Development of written fall protection rescue procedures; and
      - Selection and use of non-certified and certified anchorage points.
      - First aid, CPR and recognition and treatment of suspension trauma (Orthostatic Incompetence).
   (v) Competent rescue training shall be conducted at least annually.
(e) PROCEDURE:

(1) A rescue plan must be a part of the Activity Hazard Analysis (AHA) or Job Safety Analysis (JSA) for any job that is to be performed that requires work at heights at or above 6 feet. In all cases where an employee falls and rescue procedures must be implemented call 911. Ensure that the fire department and Emergency Medical Service (EMS) responders are informed that suspension trauma may be involved with the rescue. Initially after a fall that is arrested by fall protection equipment, the fallen worker may appear to have suffered no injury. Often, internal injuries may not be immediately apparent but may be fatal if not medically treated properly. The rescue plan shall include consideration of the following rescue types and circumstances:

(i) **Self-Rescue:** If the competent person supervising those working at heights makes proper choices in the equipment to be used and the worker uses the equipment properly, then 90% of fallen workers will be able to perform self-rescue which should include:
   - Worker will climb back up to the level from which they fell. The worker will usually use an extension ladder to climb back to the bridge deck or surface from which they have fallen.
   - Worker will return to the bridge deck, ground, or other surface and receive prompt medical care and evaluation.
   - Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(ii) **Assisted Self-Rescue:** Assisted Self-Rescue with mechanically aided hauling/rope system that is manually operated. The goal of the assisted self-rescue is for the fallen worker to perform as much of the rescue as possible with assistance. Therefore, if self-rescue is not possible then the worker must be safely retrieved by the use of an assisted self-rescue system which uses a manual mechanical advantage for a hauling/rope system. The following guidelines should be used during a manual mechanically aided rescue:
   - The static load requirements: The mechanical device may be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
   - The haul line may be swung over or lowered to the worker, who will grab the lifeline hook and secure it to the appropriate body support D-ring. As a general rule, it is not recommended snapping two snap hooks from separate fall protection equipment into the same D-ring. The front D-ring may be also be used to attach to the haul line. In self-rescue, the front D-ring may give the fallen employee greater control staying away from fixed objects in front of them. Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member, all rescue personnel involved in the rescue and the employee (if capable) must all verify that a secondary fall protection or haul line used with a self-retracting lifeline (SRL) has a positive connection. Verification of positive connection to the haul line may be made by the worker hoisting themselves up where the arrest lanyard or SRL is visibly slack. Once all involved have verified a positive connection to the rescue equipment, the lead member of the rescue team may order releasing the lanyard or self-retracting life line that arrested the worker’s fall.
   - If possible, the fallen worker will raise or lower themselves to the appropriate work platform or ground. If the fallen worker cannot raise or lower themselves, then a member of the rescue team must raise or lower the fallen worker to the platform or ground. After the employee has been rescued from their arrested fall, the employee will receive prompt medical attention for all serious injuries, including treatment for possible suspension trauma. (A fact sheet on **Preventing Suspension Trauma** is available from ARTBA.)
   - Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it the appropriate level of management to conduct an accident investigation.

(iii) **Mechanically Aid Assisted Rescue:** Rescue with manual mechanically aided hauling/rope system by a rescue team member(s). If the workers injuries prevent them from attaching themselves to the rescue system, both self-rescue and assisted self-rescue are not options, and a fully assisted rescue must be performed.
(e) PROCEDURE (cont.):

- The static load requirements: The mechanical device will be secured to a non-certified anchor that is rated for at least 3,000 lbs. (13.3kN) or to a certified anchorage of five times the applied load.
- A rescue team member must attach the mechanical device haul line to the fallen worker’s fall arrest system. This can be performed by accessing the worker and attaching to the worker’s harness or use a rescue pole for the attachment. The rescue team could also attach a rescue grab to the lanyard or vertical lifeline.
- The rescue team will raise or lower the fallen worker to the appropriate work platform or ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the worker’s fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date, and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

(iv) Aerial Work Platform Assisted Rescue: Rescue with mechanically aided aerial work platform. Another means to perform an assisted rescue is with an aerial work platform using the following guidelines:

- At least one rescue worker who has been trained to safely operate the aerial work platform will get into the aerial lift and make sure there is a second fall protection device such as a shock absorbing lanyard or SRL available for the fallen worker who is being rescued.
- The aerial lift will be maneuvered into position and then raised up under the worker to be rescued.
- The rescue worker will attach the second lanyard or SRL from the aerial work platform to the fallen worker to be rescued.
- Before releasing the lanyard or self-retraction life line that arrested the worker’s fall, the lead rescue member and all rescue personnel involved in the rescue and the fall victim (if capable) must all verify that a positive connection from the aerial work platform to the fall victims harness. The rescue worker after receiving permission from the lead rescue worker, may disconnect the lanyard or SRL involved in arresting the worker’s fall.
- Lower the worker to the ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal flotation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water and that the employees will not use or be required to use fall protection equipment as well. When working on a high bridge with a significant fall hazard employees should be utilizing fall protection. The fall impact forces to water from a high bridge could be severe enough to cause death.

(v) Mobile Crane Supported Platform Assisted Rescue: Rescue by use of a personnel platform attached to mobile crane. Another means to perform an assisted rescue is with a personnel platform suspended by a crane using the following guidelines:

- The crane operator must be trained to perform crane operations using a personnel platform for rescue of a fallen worker.
- The employer and the crane operator must ensure that the crane, the personnel platform, and fall protection required is in accordance with OSHA Crane Standard in 29 CFR 1926.1431.
- If the employer anticipates the possible need to use a personnel platform suspended by a crane to rescue a potential fall victim, the crane operator and the rescue team will perform a trial lift prior to worker exposure to a fall hazard. All rescue equipment and the personnel platform must be in the ready position to be attached and suspended by the crane to perform the rescue in a timely manner.
(e) PROCEDURE (cont.):

- At least one rescue worker will get onto the personnel platform and make sure there is a second fall protection device such as a shock absorbing lanyard or SRL available for the fallen worker who is being rescued.
- The crane will be maneuvered into position and then raised up under the worker to be rescued in the same manner as the trial lift. The rescue worker will attach the second lanyard or SRL from the aerial work platform to the fallen worker to be rescued.
- Before releasing the lanyard or self-retracting life line that arrested the worker’s fall, the lead rescue member and all rescue personnel involved in the rescue and the fall victim (if capable) must all verify a positive connection from the personnel platform anchorage point to the fall victims harness. The rescue worker after receiving permission from the lead rescue worker may disconnect the lanyard or SRL involved in arresting the worker’s fall.
- Lower the worker to the ground. After the employee has been rescued from their arrested fall the employee will receive prompt medical attention for all serious injuries, including treating for possible suspension trauma.
- Site management will remove all necessary components of the workers fall arrest system from service and document (bag/tag) the components involved in the fall with the name, date and activity at the time of the fall and give it to the appropriate level of management to conduct an accident investigation.

NOTE: OSHA states that fall protection equipment is not required when working over water. When working over or near water, the requirements of 29 CFR 1926.106 apply. Employees working over water and exposed to fall hazards should be provided a fall protection harness and a personal flotation device (PFD). For comfort the employee should be provided a combination harness/PFD. The employer should evaluate on a case-by-case basis if only a PFD will be utilized over water when working from an aerial lift or suspended by a crane. When working on a high bridge with a fall hazard of 40 feet or more to the water fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA states a PFD alone is not adequate if the height of the potential fall is 40 or more feet or there is a potential of striking a structural member during the fall or striking something floating in the water. In these cases the employee must be tied off.

(vi) Crane as an Anchorage Point: Anchoring to the load line of a crane. When using the load line of a crane as an anchorage point ensure compliance with OSHA Standard 29 CFR 1926.1423(g), (j) and (k) is mandatory. Personal fall arrest system or rescue equipment for fall arrest is permitted to be anchored to the crane/derrick's hook (or other part of the load line) where all of the following requirements are met:

- A qualified person has determined that the set-up and rated capacity of the crane/derrick (including the hook, load line and rigging) meets or exceeds the requirements of a 5,000 lbs. (22.2 kN) anchorage point per employee attached. If one rescue worker and one employee to be rescued are secured to the hook, load line or rigging than the rated capacity for the crane at the radius and angle of the boom must exceed 10,000 lbs. (44.4 kN) on the load chart for the crane.
- The crane operator must be at the work site and informed that the equipment is being used as an anchorage point for fall protection or for fall rescue equipment.
- No load is suspended from the load line when the personal fall arrest system is anchored to the crane/derrick's hook (or other part of the load line).
- **Training.** The employer must train each employee who may be exposed to fall hazards while on, or hoisted by, equipment covered by OSHA's crane standard on all of the following: The requirements of this rescue plan and OSHA's fall protection standard.
(f) ANCHORAGE POINTS (ANSI/ASSE Z359.2 Section 5.4):

<table>
<thead>
<tr>
<th>Strict Load Requirements</th>
<th>Non-Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
<td></td>
</tr>
</tbody>
</table>

(g) ASSEMBLY, MAINTENANCE, INSPECTION, DISASSEMBLY PROCEDURES

Assembly and disassembly of all rescue and equipment will be done according to manufacturers’ recommended procedures. A copy of the manufacturer’s product manuals for each type of rescue and fall equipment used will be on-site.

A site specific list of rescue and fall equipment used on this job will be developed by site management. Rescue personnel will conduct a visual inspection of all rescue and fall protection equipment daily or before each use. Any defective rescue and fall protection equipment will be tagged and removed from service immediately. The manufacturer’s recommendations for maintenance and inspection will be followed.

(h) FALL PROTECTION ENFORCEMENT/DISCIPLINARY POLICY

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand if they knowingly violate the company’s policy they will be terminated. Employees must understand if they knowing violate the company’s policy of fall protection they will be terminated as well. The company’s enforcement and disciplinary policy should address actions that will be taken against sub-contractors as well. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company’s fall protection policy or retraining with a written counseling statement.

(i) REFERENCES TO ANSI / ASSE Z359 FAMILY OF CONSENSUS STANDARDS

The following five ANSI/ASSE Z359 series of consensus standards provides for a “systems approach” to implementation of a fall protection program:

- Z359.0 Definitions and Nomenclature Used for Fall Protection and Fall Arrest
- Z359.1 Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components
- Z359.2 Minimum Requirements for a Comprehensive Managed Fall Protection Program
- Z359.3 Safety Requirements for Positioning and Travel Restraint Systems
- Z359.4 Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components

(j) AUTHORIZATION:

Signature:

Date:

Name:

Title:

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.
Sample Rescue Plan

IMPORTANT: This document is intended to provide guidance only for developing site-specific working at heights rescue plans for bridge contractors.

Date: _____  Job Description: __________________________________________________________

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>*Method of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated Competent Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Rescue Person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Rescuer(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Contact(s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Denotes: Verbal (Face-to-face), Radio Channel (specify channel), phone number or other forms of communication.

Onsite Rescue Equipment (indicate a yes or no for each box)

<table>
<thead>
<tr>
<th>Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder</td>
<td>Pulley System</td>
</tr>
<tr>
<td>Rescue Pole</td>
<td>Brake-Tube System</td>
</tr>
<tr>
<td>Rescue Rope</td>
<td>Winch System</td>
</tr>
<tr>
<td>Crane as Anchorage Point</td>
<td>Controlled Descent</td>
</tr>
<tr>
<td>Crane with a Personnel Platform</td>
<td>Rope Ladder</td>
</tr>
<tr>
<td>Scaffold</td>
<td>Skiff</td>
</tr>
<tr>
<td>Aerial Work Platform</td>
<td>Life Ring with 90 feet of rope</td>
</tr>
<tr>
<td>Vertical Rescue &amp; Escape System</td>
<td>First Aid Kit</td>
</tr>
<tr>
<td>Self-Retractable Lifeline</td>
<td>Stokes basket</td>
</tr>
</tbody>
</table>

Pre-Planning for Rescue and Fall Protection Equipment

<table>
<thead>
<tr>
<th>Yes/No</th>
<th>Rescue and Fall Protection Planning</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Have alternatives to using fall arrest equipment been considered?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Has rescue equipment been inspected and found in serviceable condition?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is equipment adequate for the rescue plan?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Have communications devices been identified, located, and tested?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are all rescuers familiar with the use of the rescue equipment?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If working over water, is there a skiff and life rings?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are PFDs worn by worker when working over water?</td>
<td></td>
</tr>
</tbody>
</table>

Describe tasks to be done prior to work to prevent a fall and the step-by-step process to be followed in the event of a fall.

Pre-Work Tasks and Response Procedures

<table>
<thead>
<tr>
<th>#</th>
<th>Pre-Work Task</th>
<th>Response Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AHA (Activity Hazard Analysis) and/or JSA (Job Safety Analysis) has been developed for this task</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Perform trial test of rescue equipment</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
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<td>4</td>
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<tr>
<td>6</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

ARTBA Work Zone Safety Consortium

American Road and Transportation Builders Association  •  U.S. Department of Transportation Federal Highway Administration
National Asphalt Pavement Association  •  Texas A&M Transportation Institute
International Union of Operating Engineers  •  FOF Communications
Community College Consortium For Health and Safety Training  •  American Association of State Highway and Transportation Officials

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Employee Fall Protection Training Record

This company has a written fall protection program that details its responsibilities under Occupational Safety and Health Administration (OSHA) fall protection requirements: 29 CFR 1926 Subparts E (Personal Protective Equipment 1926.105 - 106), L (Scaffolding 1926.450 - 454 and Appendices A - E), M (Fall Protection 1926.500-503 and Appendices A - E), R (Steel Erection 1926.760 - 761 and Appendices D and G) and CC (Cranes and Derricks 1926.1423). All employees will be trained by a competent person* who is qualified prior to any job assignment where fall protection is required. The training will enable each employee to recognize fall hazards and to follow appropriate procedures that minimize the hazards. This record certifies the following employees have been trained to recognize fall hazards and to use appropriate fall protection systems and methods to minimize exposure to the hazards, as required in 1926.503(b).

Employee Name: ____________________________________________

FALL PROTECTION EQUIPMENT COVERED IN TRAINING

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature* (see page 2)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock-Absorbing Lanyard</td>
<td></td>
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ARTBA Work Zone Safety Consortium
- American Road and Transportation Builders Association
- National Asphalt Pavement Association
- Community College Consortium For Health and Safety Training
- Texas A&M Transportation Institute
- FOF Communications
- U.S. Department of Transportation Federal Highway Administration
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This publication does not constitute a national standard, specification, or regulation.
### FALL PROTECTION EQUIPMENT COVERED IN TRAINING (continued)

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer / Model#</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Straps</td>
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<tr>
<td>Anchorage</td>
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<tr>
<td>Safety Nets</td>
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<tr>
<td>FP on Aerial Work Platforms (AWP)</td>
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<tr>
<td>FP on Crane-Supported Personnel Platforms</td>
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<td>Other:</td>
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<td>Other:</td>
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</tbody>
</table>

**Warning Access Zones and Safety Monitors:** For leading edge work [29 CFR 1926.501(b)(2)] and precast concrete [29 CFR 1926.501(b)(12)] work where the employer can demonstrate that it is infeasible or creates a greater hazard to utilize conventional fall protection equipment, the employer may decide to use controlled access zones and safety monitors. The OSHA position is that it is feasible and the employer has the burden to provide proof that it is infeasible and to prepare a site specific plan in accordance with 29 CFR 1926.502(k). The ARTBA position is that the conventional fall protection is feasible in these activities.

### OSHA STANDARD / COMPANY PROGRAM COVERED IN TRAINING

<table>
<thead>
<tr>
<th>OSHA Standard / Company Program Covered in Training</th>
<th>Employee Signature</th>
<th>Trainer Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company's Written Fall Protection Program</td>
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<tr>
<td>Company's Written Fall Protection Rescue Plan</td>
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<td></td>
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<tr>
<td>Trained to Perform Rescue of Fallen Worker Suspended by Fall Arrest</td>
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<tr>
<td>Subpart E (Safety Nets) 29 CFR 1926.105</td>
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<tr>
<td>Subpart E (Working Over Water) 29 CFR 1926.106</td>
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<tr>
<td>Subpart L (Scaffolds/Aerial Lifts) 29 CFR 1926.450-454 and Appendix A - E</td>
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<tr>
<td>Subpart M (Fall Protection) 29 CFR 1926.500-503 Appendix B - E</td>
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<tr>
<td>Subpart R (Steel Erection) 29 CFR 1926.750 - 761 and Appendix A - H</td>
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<tr>
<td>Subpart CC (Crane Standard) 29 CFR 1926.1423 and 1431</td>
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</tbody>
</table>

* I certify that I have trained the employee/worker for the equipment, company programs and/or OSHA standards listed above. I also certify that I am a competent person who is qualified to provide this training. A Competent Person is one who is capable of identifying existing and predictable hazards [OSHA 29 CFR 1926.32(f)], authorized to take prompt corrective measures to eliminate hazards [OSHA 29 CFR 1926.32(f)]; and qualified to train employees in all aspects of fall protection covered in OSHA Subpart M [29 CFR 1926.503 (Subpart M)].
This template is intended to aid bridge contractors in developing an overall fall protection plan that includes use of conventional fall protection systems (guardrails, personal fall arrest, personal fall restraint, safety nets, and/or work positioning devices). Such an overall plan can then be adapted for specific work sites. The written plan tells how to control each fall hazard. It lists the fall protection measures to be used, how they are to be used, and who is responsible for supervision and training.

If a bridge contractor wishes to declare an exception to the use of conventional fall protection, Occupational Safety and Health Administration (OSHA) regulation requires a site-specific fall protection plan for using alternative fall protection methods. Such an exception can be made only when the contractor demonstrates that use of conventional systems is not feasible and/or will create a greater hazard. OSHA and the Occupational Safety and Health Review Commission (OSHRC) have placed the burden of establishing ‘infeasibility’ and ‘greater hazard’ claims on the employer. When contractors declare an exception, they must implement a written site-specific fall protection plan which complies with 29 CFR 1926.502(k), in lieu of implementing conventional fall protection.

Bridge contractors can declare an exception to use of conventional fall protection equipment only for leading edge work and precast concrete work. The ARTBA position is that conventional fall protection equipment is feasible and that implementation of the use of conventional fall protection systems will not create a greater hazard.

**THIS BRIDGE FALL PROTECTION PLAN WILL BE AVAILABLE ON THE JOBSITE FOR INSPECTION**

All employees who will be working on this job site will be made aware of the fall hazards and will understand the means to prevent falls and to minimize the injury or death potential of a fall. All employees will be informed of the company policy of enforcement and discipline for this plan. All employees will also be aware of the employer’s rescue plan in the event of a fall.

<table>
<thead>
<tr>
<th>(a) Site-Specific Job Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Name:</td>
</tr>
<tr>
<td>Job Site Location:</td>
</tr>
<tr>
<td>Site Superintendent:</td>
</tr>
<tr>
<td>Site Foreman:</td>
</tr>
<tr>
<td>Designated Qualified Person:</td>
</tr>
<tr>
<td>Designated Competent Person:</td>
</tr>
<tr>
<td>Employees Authorized To Use Fall Protection Equipment:</td>
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</tbody>
</table>
(b) Specific Fall Hazards Associated with the Bridge Work Area:

Include locations and dimensions for the hazards, such as but not limited to openings, leading edge work, deck perimeters, bridge structural members, etc. Work tasks that put workers at risk of falls include abutment construction, column or cap forming, stripping formwork, girder installation, deck placement, forming barrier rail, placement of concrete, paving, etc.

(c) Method of Personal Fall Arrest (PFAS) or Personal Fall Restraint (PFRS):

For all PFAS or PFRS equipment, include the type of equipment, manufacturer's name, and the model number.

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
<th>Type of Equipment</th>
<th>Manufacturer</th>
<th>Model#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Harness</td>
<td></td>
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<td>Relief Straps</td>
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<tr>
<td>Shock-Absorbing Lanyard</td>
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<td>Work Positioning Lanyard</td>
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<td>Self-Retracting Lifeline (SRL)</td>
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<td>Other:</td>
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<td>Restraint Line</td>
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<td>Other:</td>
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</tbody>
</table>
(c) Method of Personal Fall Arrest or Personal Fall Restraint (cont.):

Anchorage points: according to ANSI/ASSE Z359.2 Section 5.4

<table>
<thead>
<tr>
<th>Static Load Requirements</th>
<th>Non-Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Arrest System</td>
<td>5,000 lbs. (22.2 kN)</td>
<td>2 X maximum arresting force</td>
</tr>
<tr>
<td>Work Positioning Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Restraint &amp; Travel Systems</td>
<td>1,000 lbs. (4.5 kN)</td>
<td>2 X foreseeable force</td>
</tr>
<tr>
<td>Rescue Systems</td>
<td>3,000 lbs. (13.3 kN)</td>
<td>5 X applied load</td>
</tr>
<tr>
<td>Horizontal Lifeline Systems</td>
<td></td>
<td>Must sustain at least two times the maximum tension developed in the lifeline during fall arrest in the direction applied by lifeline forces.</td>
</tr>
</tbody>
</table>

(d) Assembly, Maintenance, Inspection, Disassembly Procedure for Personal Fall Arrest or Personal Fall Restraint:

Assembly and disassembly of all personal fall arrest, personal fall restraint, work positioning systems, horizontal lifelines, and rescue systems will be done according to manufacturers’ recommended procedures. The specific types of equipment to be used on this job are listed in paragraph (c) on page 2. A copy of the manufacturer’s product manual for each type of fall protection equipment and fall protection system used will be onsite.

A visual inspection of all equipment will be done before each use. The manufacturer’s recommendations for maintenance and inspection will be followed. Any defective equipment will be tagged and removed from service immediately. (A competent person must inspect the jobsite, materials, and equipment on a frequent/regular basis [OSHA Subpart C 1926.20].) Employees responsible for inspection are listed below:

<table>
<thead>
<tr>
<th>Employee Name:</th>
<th>Cell/Radio Channel:</th>
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<tbody>
<tr>
<td>Employee Name:</td>
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<tr>
<td>Employee Name:</td>
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<tr>
<td>Employee Name:</td>
<td>Cell/Radio Channel:</td>
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</tbody>
</table>

(e) Handling, Storage and Securing of Tools and Material:

All materials, equipment, and tools not in use while aloft shall be secured against accidental displacement. Include locations and dimensions for the specific hazards.
(f) Overhead Protection:

OSHA requires hardhats on all job sites with overhead hazards. It is recommended that hardhats be worn on all construction sites whether or not overhead hazards exist. When working aloft, workers will wear chin straps to secure their hardhats from falling off.

Warning signs will be posted to caution of existing hazards whenever they are present. For example, when steel erection, leading edge work, and pre-cast concrete erection activities are being performed above, then warning signs, barricades and/or danger tape shall clearly mark the area to prohibit workers from accidentally entering the area. In some cases, debris nets may be used if a condition warrants additional protection.

Toeboards will be used on scaffolding, personnel platforms, and aerial work platforms. If tools and/or equipment could fall over the toeboard, then additional safety measures such as – but not limited to – the use of screens to keep the tool and/or equipment on the deck of the scaffolding, personnel platform, and/or aerial work platform will be taken.

In addition to materials being hoisted, employees shall be protected from other falling objects. The bridge contractor will prohibit other construction processes below steel erection, leading edge work, and pre-cast concrete erection activities unless overhead protection is provided in addition to hardhats. If the bridge contractor is not the controlling contractor, the bridge contractor will request that the controlling contractor also communicate and enforce prohibited activity below steel erection, leading edge work, and pre-cast concrete erection activities.

(g) Rescue of Suspended or Injured Worker:

Rescue activities will be performed in accordance with the site-specific rescue plan. (A Sample Fall Rescue Plan for Bridge Work and a fact sheet on Preventing Suspension Trauma are available from ARTBA.)

(h) Working Over Water:

OSHA states that fall protection equipment is required when employees are working 6 feet or more over water. When employees are protected by fall protection 100% of the time (guardrails or personal fall arrest), OSHA does not require the use of a personal floatation device (PFD).

When employees are working over or near water and 100% fall protection is not provided, the requirements of 29 CFR 1926.106 also apply. Where a fall hazard exists of 6 feet or greater to the water, employees must be provided a fall protection harness and a PFD. For comfort, the employee should be provided a combination harness/PFD instead of requiring both a harness and a PFD to be worn simultaneously.

When employees work from aerial lifts or platforms suspended by a crane over water, tie-off using PFAS/PFRS may not be required. OSHA states by letter of interpretation that employees are not required to be tied off when working over water in an aerial lift or from a suspended platform. The employer should evaluate on a case-by-case basis whether only a PFD will be utilized over water when working from an aerial lift or suspended by a crane.

When employees work on a high bridge over water, fall protection must be utilized. A fall from a high bridge to water can result in severe injury and may be fatal. OSHA also states a PFD alone is not adequate if there is a potential of striking a structural member during the fall or striking an object in the water. In these cases the employee must be tied off.

When working over or near water, bridge contractors must ensure:

- Employees are provided with a PFD.
- Prior to and after each use, the PFD must be inspected for defects which would alter strength or buoyancy. Defective PFDs will not be used.
- Ring buoys with at least 90 feet of line must be provided and readily available for emergency rescue operations. Distance between ring buoys will not exceed 200 feet.
- At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.
(i) Guardrail Systems:

In general, guardrails are the preferred fall protection system when feasible. Whenever feasible, the company will select and install guardrail systems before resorting to use of personal fall arrest (PFAS) or personal fall restraint. Include locations where use of guardrail systems is feasible and guardrails will be installed.

(j) Safety Nets:

Where feasible, safety nets are an effective fall protection system. Like guardrails, nets require no special effort on the part of workers who are protected by them. Nets must be rigged high enough so that fallen workers do not hit the ground. Nets must be installed as close as practicable under the working surface, but in no case more than 30 feet below it. When nets are used on bridges, the potential fall area must be unobstructed. Include locations where use of safety nets is feasible and safety nets will be installed.

(k) Training Program:

An Employee Fall Protection Training Record is available from ARTBA. Company training program requirements for employees who might be exposed to fall hazards will include:

- Trained by a competent person concerning proper use and limitations of fall protection equipment before exposed to a fall hazard.
- Training must be conducted before employees are allowed to be exposed to fall hazards and directed to use fall protection equipment.
- Employees who have rescue duties will be trained from a competent person on how to properly rescue an employee who has had their fall arrested by fall protection equipment.
- Employees will be retrained when the nature of the work, the workplace, or the methods of control or type of fall protection equipment change to such an extent that prior training is no longer adequate.
- Training of employees in proper use of fall protection equipment will include physical demonstrations by trainees. Demonstrations by employees will verify their knowledge, skills, and proper application of fall protection equipment. Trainees will demonstrate how to inspect, anchor, assemble, and use the fall protection and rescue equipment in locations where they work.
(k) Training Program (cont.):

- Training shall include at least the following:
  - Nature of fall hazards in the work area and fall hazard recognition.
  - Fall hazard elimination and control methods.
  - Correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used.
  - Use/operation of guardrail systems, PFAS, PFRS, safety net systems, and/or work positioning systems to be used.
  - All standards contained in OSHA 1926 Subpart M and R and other applicable OSHA fall protection and rescue regulations and consensus standards, such as but not limited to ANSI/ASSE Z359 series of standards.
  - Requirements of this fall protection plan and rescue plan/procedures.
  - Pre-use equipment procedures.

- Training shall be conducted at least annually to stay current with fall protection and rescue educational requirements.

- The trainer will prepare a written certification record. The written certification record shall contain the name or other identity of the employee trained, the training date(s), the signature of the person trained, and the signature of the trainer. The latest training certification shall be maintained. (An Employee Fall Protection Training Record is available from ARTBA.)

  NOTE: OSHA requires that the trainer must be a competent person who is qualified in the following areas:
  - The nature of fall hazards in the work area;
  - The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used;
  - The use and operation of guardrail systems, personal fall arrest systems, personal fall restraint systems, safety net systems, work positioning, controlled access zones, and other protection to be used;
  - The correct procedures for the handling and storage of equipment and materials and the erection of overhead protection;
  - The role of employees in fall protection plans; and
  - The standards in 29 CFR 1926 Subpart M and R, and the requirements in ANSI/ASSE Z359 series as noted in paragraph (l) below.

(l) Fall Protection Enforcement and Disciplinary Policy:

Describe and insert the company policy for fall protection enforcement and disciplinary actions that will be taken for violators. Managers (superintendents, foremen, competent persons, and qualified persons) must understand that they will be terminated if they knowingly violate the company’s policy. Employees must understand if they violate the company’s fall protection policy they will be terminated as well. The company’s enforcement and disciplinary policy should also address actions that will be taken against subcontractors. The company should have only two choices for violations of fall protection policies: termination for knowingly violating company policy or retraining with a written counseling statement.

(m) References to ANSI/ASSE Z359 Family of Consensus Standards:

Five ANSI/ASSE Z359 consensus standards provide a “systems approach” to implementation of a fall protection program.

<table>
<thead>
<tr>
<th>ANSI/ASSE Z359 Consensus Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z359.0</td>
<td>Definitions and Nomenclature Used for Fall Protection and Fall Arrest</td>
</tr>
<tr>
<td>Z359.1</td>
<td>Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components</td>
</tr>
<tr>
<td>Z359.2</td>
<td>Minimum Requirements for a Comprehensive Managed Fall Protection Program</td>
</tr>
<tr>
<td>Z359.3</td>
<td>Safety Requirements for Positioning and Travel Restraint Systems</td>
</tr>
<tr>
<td>Z359.4</td>
<td>Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components</td>
</tr>
</tbody>
</table>

(n) Authorization:

<table>
<thead>
<tr>
<th>Signature:</th>
<th>Date:</th>
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</table>

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
</tr>
</thead>
</table>

NOTE: Company’s fall protection policy should be signed by the highest level of management within the company.

ARTBA Work Zone Safety Consortium

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