



Fall Protection: Calculating Clearances when Using ANSI Z359.13 Lanyards

Fact Sheet

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Serious injuries can occur if a worker impacts the ground or other lower obstruction. When a fall arrest system is being used, it is essential to know both the required and the available clearances.

What is a lanyard?

A lanyard is a short, flexible line of rope, wire rope, or webbing strap with connectors at each end. Lanyards are attached to a full body harness at one end, and to a deceleration device, shock absorber, anchorage connector, or anchorage point at the other end. Many lanyards include an internal or external shock absorber designed to reduce the force exerted on a worker in the event of a fall. Lanyard requirements include:

- Must be flexible rope, wire rope, or webbing strap
- May be no longer than 6 feet
- Must hang freely
- Must be attached to or include a deceleration device that slows the worker to a stop in the event of a fall
- Must meet a minimum tensile load of 5,000 lbs.

Use of Old ANSI Z359.1 Lanyards

ANSI Z359.1 “American National Standard Safety Requirements for Fall Arrest Systems, Subsystems AND Components” was originally published in 1992. The purpose of this standard was to address the variety of equipment being developed in the rapidly growing field of fall protection. The original Standard included the following equipment: harnesses, lanyards (including self-retracting lanyards), lifelines, energy absorbers, anchorage connectors, fall arrestors, and components of such equipment including connectors, rope, straps, thread and thimbles. This Standard was intended to be the first in a series of

Standards to address a complete comprehensive fall protection program.

The commonly used 6-foot-long ANSI Z359.1 energy-absorbing lanyard was intended to safely stop a 6-foot free fall of a worker weighing up to 310 lb.

Unfortunately, the 6-foot length lanyard will allow a worker to free fall up to 12-feet if the lanyard is anchored at or below the worker's feet (see Figure 1).

For lanyard systems, knowing the worst-case deployment of the Personal Energy Absorber (PEA) makes clearance calculations easy. Figure 2 shows how to add up all the factors to understand that the anchor must be at least 17.5 feet above the ground with the old (ANSI Z359.1) equipment.

This method of calculating the “required clearance” is also appropriate for a 12-foot free fall, because the PEA is always assumed to deploy exactly 3.5 feet for ANSI Z359.1 equipment. However, in 12-foot free falls the impact forces that occur after “bottoming-out” the PEA can exceed the 1,800-lb. limit allowed by OSHA.



Figure 1. An example of an anchor point located below the worker's feet.

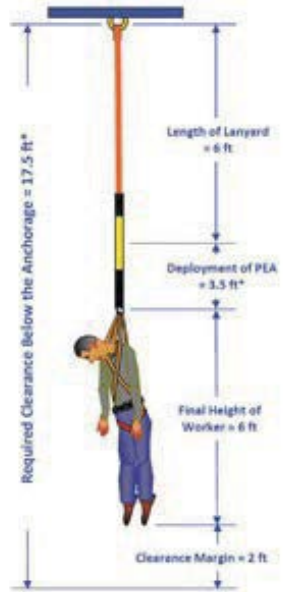


Figure 2. Determination of the anchor point for ANSI Z359.1 equipment.



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Concerns with using ANSI Z359.1 Lanyards

For workers weighing up to 240 lbs., the ANSI Z359.1 lanyards provide appropriate protection for a 6-foot free fall. The Z359.13 lanyards were needed because:

- When using a 6-foot lanyard, unless the anchorage is at or above the worker's shoulders, free falls will exceed 6 feet.
- Even when free falls are less than six feet, experts now recognize that the test mass in ANSI Z359.1 may not properly represent a 310-lb. worker.

The old (Z359.1) requirements were developed several decades ago, based on the commonsense principle that the human body absorbs some of the fall energy. Studies at that time showed for rope lanyards without PEAs that a 1.4 ratio between human and test mass was appropriate (220-lb. rigid mass representing a 310-lb. worker).

Recent studies have shown that because PEAs reduce the impact force, the energy absorbed by the worker is much less. The newest ANSI Z359 standards use a 282-lb. rigid test mass to represent a 310-lb. worker.

Since the Z359.13 PEAs must absorb more fall energy, the standard recognizes that they may need to deploy more than 3.5 feet.

Use of ANSI Z359.13 Lanyards

ANSI Z359.13-2013 (R2022) Personal Energy Absorbers and Energy Absorbing Lanyards was initially approved and became effective November 16th, 2009. The latest version was approved July 26th, 2022. This standard establishes requirements for the performance, design criteria, marking, qualification and verification testing, instructions, inspections, maintenance and removal from service of

personal energy absorbers and energy absorbing lanyards for users within the capacity range of 130 to 310 pounds (59 - 140kg.). It is the intention of this standard to require all personal energy absorbers and energy absorbing lanyards to reduce the forces implied on the user to less than 10 Gs (10 times the normal gravitational pull of the earth). Users below 130 pounds may experience forces higher than 10 Gs. The requirements of this standard supersede any corresponding requirements in the ANSI/ASSP Z359.1-2007, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components.

This standard provides two classes of PEAs:

- The "6 ft. FF" PEA is intended for a maximum 6-foot free fall and can deploy up to 4 feet.
- The "12 ft. FF" PEA is intended for a maximum 12-foot free fall and can deploy up to 5 feet.

Since the PEAs deploy further, the "required clearance" might be affected. Please note that the 6-foot free fall capable lanyard, which is 72" long, is only allowed when the tie-off point is at the D-ring elevation or higher.

Does OSHA allow free falls to exceed 6 feet and PEAs to deploy more than 3.5 feet?

OSHA has not changed free fall and deceleration distance limits. These easily understood objectives provide good guidelines for workers. However, the agency recognizes that in some situations, these objectives are difficult to achieve and that exceeding these limits can be safe if two (fundamental) objectives are met:

- the impact force to the worker remains below 1,800 lbs.; and
- the fall stops within the available clearance.



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Interpretation letters posted on the OSHA website stipulate that when these objectives are met, OSHA will accept greater free fall and deceleration distances. The Z359.13 standard was written, in part, to provide equipment that meets the first objective. This fact sheet focuses on how this equipment affects the second objective.

OSHA says that where an employer is using a fall arrest system that permits a fall of more than six feet, a citation should be issued under 29 CFR 1926.104(d) unless the employer shows that (1) limiting an arrested fall to six feet is infeasible; (2) the arresting fall distance, though more than 6 feet, is as short as feasible; (3) it has taken reasonable steps to determine that (a) the arresting forces will be limited to 1800 pounds and (b) the system will not fail in an arrested fall.

When using the Z359.13 equipment, do the required clearances need to increase?

At first glance, if clearance is calculated based on the assumption of full deployment (bottoming-out) of the PEAs, then yes, the clearance distance must increase by 0.5 and 1.5 feet respectively for the “6 ft. FF” and “12 ft. FF” lanyards. (Remember that the new “6 ft. FF” PEA deploys up to four feet, 0.5 feet greater than the old PEA, while the new “12 ft. FF” PEA deploys up to 5 feet, 1.5 feet greater than the old PEA.) However, the clearance increases are not warranted in systems that were properly designed for the Z359.1 lanyards, because the maximum deployment for these lanyards is 3.5 feet. Figure 3 shows the factors that make up the clearance distance.

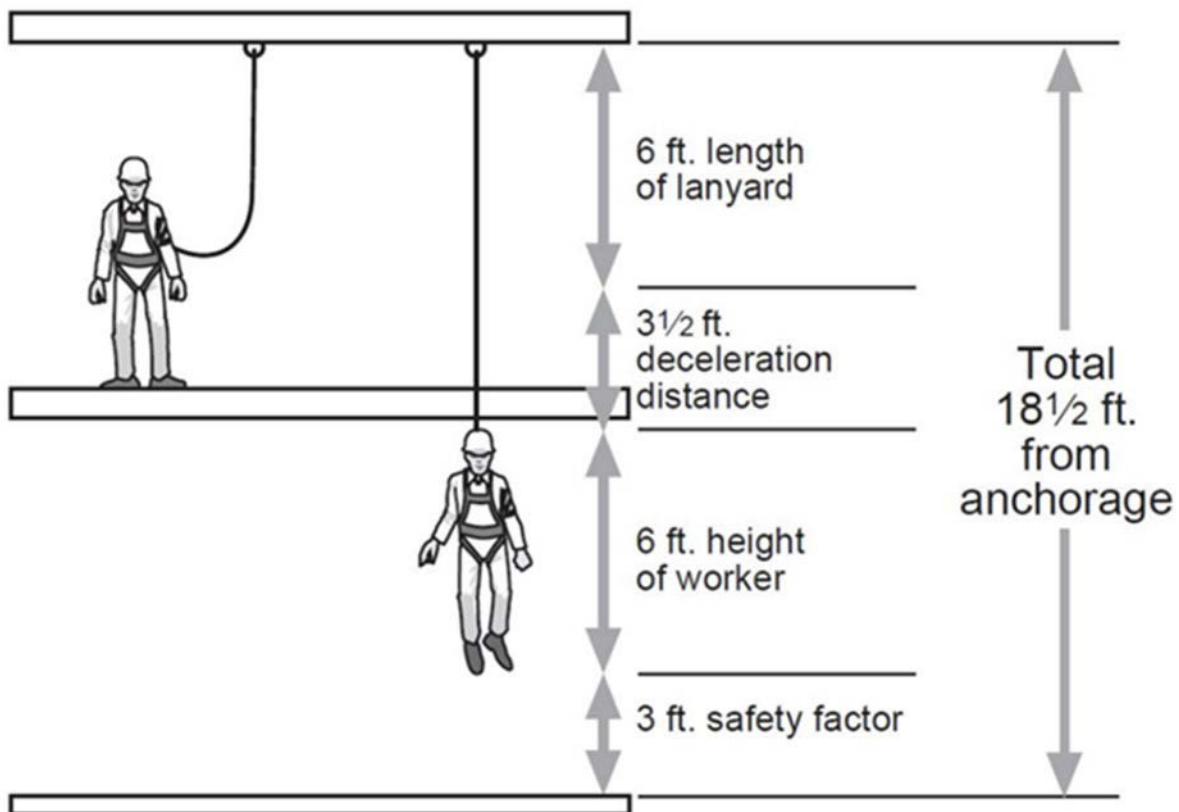


Figure 3. Clearance distance from a fall.



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The 12-foot free fall (FF) personal energy-absorbing lanyard will require the user to calculate a clearance from the anchor point to the obstructions, equipment, and/or the ground below of approximately 20 feet. This calculation includes a 3-foot safety factor. When comparing the identical workspace of a potential fall arrest for a 6-foot FF vs. 12-foot FF, the 12-foot FF would require approximately 7' additional clearance below the worker (additional 6-foot FF plus 1-foot energy absorber deployment).

It is rare for PEAs to fully deploy in actual falls unless the worker weighs greater than 310 lbs. The new lanyards absorb energy with equal (and often greater) efficiency than the old ones. Thus, the same or less deployment (and clearance) in actual falls with the new equipment generally is expected. Any scenario that would not bottom-out the old PEAs will NOT deploy the new ones beyond 3.5 feet.

The only time deployments greater than 3.5 feet may occur with the Z359.13 lanyards is for heavy workers and large free falls that would actually bottom-out the Z359.1 lanyards. The following options apply in this case:

- Keep using the Z359.1 lanyards to maintain present clearance requirements. However, impact forces

will spike when this equipment bottoms-out and, therefore, should be determined by a “qualified person” to verify compliance with the 1,800-lb. OSHA limit.

- Use the new Z359.13 lanyards to keep impact force below 1,800 lbs. Doing so will sometimes (but not always) increase clearance requirements due to greater deployment. Clearances should be checked by a qualified person if a worker’s weight exceeds 240 lbs. or free fall exceeds six feet.

Can you continue to purchase ANSI Z359.1 energy-absorbing lanyards?

Yes, for now. The Z359 committee is developing individual standards for each type of fall protection equipment. The committee intends to eventually withdraw ANSI Z359.1. Also, the ANSI Z359.13-2013 standard is a voluntary standard, so you are not required by law or OSHA regulation to replace your existing equipment.

When may the new PEAs exceed 3.5 feet of deployment?

This will only occur for large free falls of heavier workers. It is possible to provide conservative guid-

KEY FACTS

- Correctly developed clearance requirements assuming fully deployed ANSI Z359.1 energy-absorbing lanyards are still valid and safe for ANSI Z359.1 and ANSI Z359.13 PEAs if the worker weighs less than 240 lbs. and the free fall distance is less than 6 ft.
- Greater free falls might not cause more than 3.5 feet of deployment of ANSI Z359.13 equipment, but weight limits should be determined by a “fall protection qualified person” for the actual equipment and free falls involved. A fall protection expert can determine when greater clearances are needed or how much impact can be expected if the PEA “bottoms out.”
- When ANSI Z359.13 PEAs are determined to deploy more than 3.5 feet (needing more clearance than ANSI Z359.1 PEAs), it is critical to use ANSI Z359.13 equipment to prevent impacts.



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ance about when workers' weight should be factored into clearance calculations.

Using ANSI Z359.6, Specification and Design Requirements for Active Fall Protection Systems, a maximum worker weight can be determined for both the "6 ft. FF" and "12 ft. FF" PEAs that will cause them to deploy exactly 3.5 feet.

The minimum average deployment force for the new PEAs must be considered to get a universally safe answer. Ultimately, the average force must be at least 705 lbs. for a "6 ft. FF" PEA and 959 lbs. for a "12 ft. FF" PEA to pass ANSI Z359.13. Note that labeling on these devices is mandated to state that the average forces are, respectively, 900 lbs. and 1,350 lbs., but this information is generally NOT reliable

since these values represent the maximum force allowed by the standard rather than the actual force. The force shown on the label usually overestimates the ability of these devices to absorb energy. Anyone completing these calculations must use accurate information obtained from the manufacturer or dynamic tests.

To cause PEA deployment of exactly 3.5 feet of the lowest-force PEA that could pass ANSI Z359.13, calculations show the maximum worker weight is 310 lbs. for:

- a 6-foot free fall, using a "6 ft. FF" PEA deploying at 705 lbs.; and
- a 12-foot free fall, using a "12 ft. FF" PEA deploying at 959 lbs.

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