

Chapter IV – Connecting Devices

4.1 Fixed Length Energy-Absorbing Lanyards

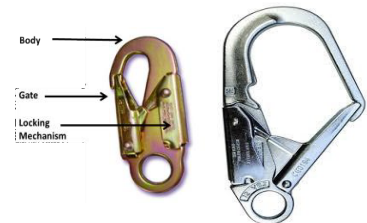
An energy-absorbing lanyard is a flexible line of rope, wire cable, or webbing which has a connector at each end for uniting the full body harness to the anchorage connector on the anchorage point. Utilizing the synthetic web-style lanyard shown below the main components of an energy-absorbing lanyard can be discussed.



4.1.1 Snaphooks & Carabiners

Snaphooks / Carabiners

The “snaphook” is a type of hardware specific to connection devices. In most cases it is “integrally” connected to the lanyard, meaning that it is not removable. The snaphooks shown on the lanyard are the most common type that can be found, although a larger version of them known as the “rebar” or “pelican” hook is also available, as shown to the right.



Standard Snap/Rebar Snaphook

A carabiner is an alternative to a snaphook that will be found on SRLs. Although they have a slightly different shape and locking mechanism, the rules for them are the same.

Note: While snaphooks have been “locking” for more than 20 years, “twist lock” carabiners where the gate must be rotated various times to lock or unlock are still readily common. For fall protection purposes, **only auto locking snaphooks and carabiners are permitted.**



Carabiner

The main difference between large and small snaphooks or carabiners is that with the larger opening it is possible to go around larger objects. Regardless of size, there are some rules surrounding snaphooks that always apply:

- **Compatibility** – The hook must be enough smaller than the hardware into which it is being connected so as not to permit force to be placed onto the gate in any possible orientation in a fall.

The picture to the right shows a compatible connection because when hanging on this “D-ring” in an abnormal configuration the gate of the hook is not being touched.






- **Gate Strength** – In the case where a mistake is made and the gate does accidentally come into contact with something that can push on it, it must be strong enough that it cannot be forced open.

To address this issue special snaphooks, known as ANSI (American National Standards Institute) snaps, are built with a gate that can withstand 3,600 pounds when pushed from the front or side and the gate is completely closed. This special snaphook is now the OSHA requirement and must be on all equipment regardless of when it was purchased. ANSI gates will be marked.



4.1.2 Lanyard Material (Web, Cable, Stretchable Web)

The second main component is the material that forms the lines between the two end snaphooks.

	<p>Web Lanyard</p> <ul style="list-style-type: none"> • 1”-wide nylon or polyester webbing, fixed or adjustable lengths
	<p>Synthetic Webbing</p> <ul style="list-style-type: none"> • Recommended for more rugged environments where abrasions, cuts, and exposure to chemicals is possible
	<p>Stretch Web Lanyard</p> <ul style="list-style-type: none"> • This is still web-based lanyard, but the elasticity keeps the lanyard as short as possible when not in-use.

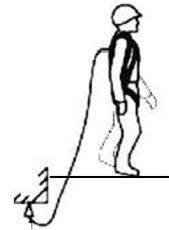
The most common length from snaphook end to snaphook end generally *is 6 feet*.

4.1.3 Energy-Absorber

The first major question when selecting a lanyard is how much “free fall” will be possible in the work situation. Quite often the worker must attach to anchor points that are below their back D-ring, such as at waist level or near their feet. And while this may not present an obvious problem, the issue is actually a very serious one. Consider the following pictures:



- Worker is attached **above** his dorsal D-ring.
- He will travel no more than 6’ before his lanyard begins to “catch.”



- Worker is attached **below** his dorsal D-ring.
- He will travel **up to 12’** before his lanyard begins to “catch.”

Attaching a standard lanyard too low will result in more free fall than this style was designed to handle, possibly leading to **maximum arrest forces upwards of 3,000 pounds**. A lanyard with a sufficient “energy-absorber” needs to be selected.



The energy-absorber is the part on the lanyard whose job it is to decelerate the fall victim following the build-up of fall forces during the “free fall” period so that they are not otherwise transmitted to the worker’s body in one sudden jolt. For this reason, any lanyard being used for fall arrest must have an energy absorber. The energy-absorber ensures a “maximum arrest force.”

Pack Energy Absorber

(MAF) of 1,800 pounds when a lanyard is used as designed.

4.1.4 Free Fall Definition

Free Fall – Before the Absorber Functions

- The beginning part of a fall, starting from the time the worker leaves the surface where they were standing, and gravity starts to pull them downward. Free fall ends as soon as the worker’s lanyard straightens and starts to catch them.

4.1.5 Deceleration Definition

Deceleration – When the Absorber Starts to Function

- Once the lanyard begins to “catch” the worker, this has begun. At this point the “energy-absorber” will start to tear open to brake the fall to a smooth stop.

4.1.6 White & Black Label Lanyards

ANSI has chosen to deal with this issue of free fall with two styles of lanyards:

- White Label Lanyards; &
- Black Label Lanyards

Depending on possible anchorage locations for workers, one style or the other must be chosen.

Lanyard Energy-Absorber Styles - (ANSI) Z359.13 - 2013)		
<p style="text-align: center;">White Label</p> <div style="border: 1px solid black; padding: 5px;"> <p>Warning: Maximum User Weight 130-310 lbs.</p> <p style="font-size: 24pt; font-weight: bold;">6ft. 900lbs.</p> <p>Maximum Free Fall Average Arresting Force Maximum Deployment Distance 48" Force may increase when cold and/or wet Read Instructions Before Use</p> </div>	<ul style="list-style-type: none"> • Most commonly used. • Only designed for anchorage points that are at the level of the work's back D-ring or higher 	<p><u>Specifications:</u></p> <ul style="list-style-type: none"> • Maximum Free Fall: 6 Feet • Max. Deceleration Distance: 4 Feet (48")
<p style="text-align: center;">Black Label</p> <div style="background-color: black; color: white; padding: 5px;"> <p>Warning: Maximum User Weight 130-310 lbs.</p> <p style="font-size: 24pt; font-weight: bold; color: white;">12ft. 1350lbs.</p> <p>Maximum Free Fall Average Arresting Force Maximum Deployment Distance 60" Force may increase when cold and/or wet Read Instructions Before Use</p> </div>	<ul style="list-style-type: none"> • Built with a larger energy- absorber. • Appropriate for anchorage points that are high or low 	<p><u>Specifications:</u></p> <ul style="list-style-type: none"> • Max. Free Fall: 12 Feet • Max. Deceleration Distance: 5 Feet (60")

Note 1:

The user capacity for equipment meeting ANSI standards falls within a range from **130 to 310 pounds**. Individuals who are lighter than the minimum or heavier than the maximum capacity are not compliant with the standard.



4.1.7 Specialty Lanyards

Twin-Leg Lanyards / 100% Connection



For those who need to work at heights and who will be able to maintain a stationary position, a single-leg lanyard may be appropriate. However, for many there will be the necessity to move around. As mentioned earlier in this manual, OSHA doesn't permit the worker to be disconnected for any length of time once having gone over the height activation points of their particular industry if no other form of fall protection is in-place. The twin-leg lanyard is a very important tool for this.

Twin- Leg

This lanyard type has two legs on one end that connect into a single energy-absorber and a single snaphook at the end that connects into the back of the user's harness.

- Twin-leg lanyards allow the worker the ability to practice the concept of "**100% connection**". At least one leg of the lanyard is connected at all times.



Climbing with 100% Connection

4.1.8 Inspection & Maintenance

This is an OSHA and manufacturer rule that applies each time that this, or any other part of the PFAS, is utilized during a work activity.



“Personal fall arrest systems shall be inspected prior to each use for [mildew], wear, damage and other deterioration, and defective *components shall be removed from service.*”

1910.140(c)(18) & 1926.502(d)(21),

Energy-Absorbing Lanyards

Inspection points on lanyards will be very similar to those mentioned previously with harnesses, except where components are different, as the case with snaphooks / carabiners, and the energy absorber.

Hardware:

- Oxidation – Free of Pitting & Corrosion
- Functionality – Auto-Closing & Auto-Locking
 - Whether corroded, broken, or they have been tampered with, when opened the gate must close on its own and become locked; if it does not, it must fail.
- No missing / broken parts, such as internal springs or external rivets

Energy Absorber:

- Inspect the outer cover:
 - Undeployed, Free of Holes or other Damage
 - Tags – Completely Legible

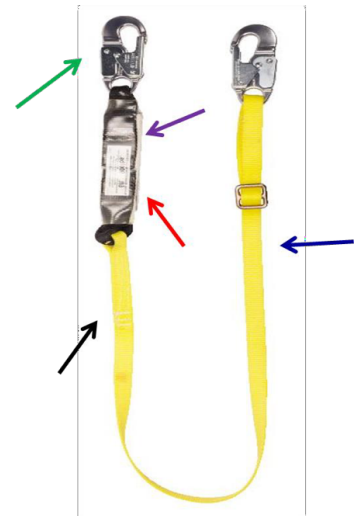
Stitching:

- Stitch points here must pass the same criteria that they did on the harness.

No Broken Threads	Entire Stitch Intact
No Stitch Unraveling	Stitched Material Not Separating

Connector Body:

- No Cuts, Tears, or Frays
- No Burns or Holes
- No Permanent Discoloration
- No Corrosion, Breaks or Bends on Wire Cable



4.2 Self-Retracting Lifelines

A “self-retracting lanyard” (SRL) is a device that contains a variable amount of drum-wound line (steel cable, synthetic webbing, or synthetic rope) that may be slowly extracted from or retracted back onto the drum under slight tension during normal movement. The snaphook at the line end is to be attached to the fall arrest D-ring on the body harness. When a fall occurs, brakes activate inside the drum, stopping the worker in a matter of inches.



SRL

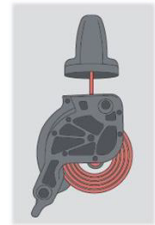
- These work on the same principles as a seatbelt in a car. Under normal conditions, the line is extracted or retracted with no locking occurring
- If the unit detects a quick extraction of line, pieces inside the unit known as “pawls” flip out to lock into a ratchet wheel bolted to the drum, stopping its rotation until a brake begins to function.

Brakes on these devices operate in a variety of different ways:

- Brake Pad – Similar to what is found in a car.
- Energy-Absorbing Coil – A coil found inside the unit straightens out in the case of the fall.
- Tear Tape Pack – A pack of the same sort found on lanyards rips open in the fall.



SRL Insides



EA Coil

Energy-absorption is available throughout the entire *working range* of the lifeline, meaning that the brake will work whether the worker falls with 6 inches of line extracted or the entire amount contained in the unit is paid-out. The energy-absorption mechanisms in the SRL limit fall forces under 1,800 pounds.

SRLs are very similar to energy-absorbing lanyards in their components. Like EALs, they have:

1. Means of connection.
2. An energy absorber.
3. A length of line.

The main differences from lanyards lie in the *amount of line* contained in one of these units and *the way the brakes work*. Otherwise, one end of the device goes to the back D-ring of the worker’s harness and the other end gets attached to the anchorage point, just like was seen with energy-absorbing lanyards.



SRL Parts

4.2.1 SRLs vs. PFLs

Originally all self-retracting lanyards were very large and designed for the housing with all of its line to be hung above the worker; now SRLs come in two types:

1. Traditional SRL – Housing is hung overhead, with the line being pulled down to connect to the worker; and
2. Personal Fall Limiter (PFL) – Small housing worn by the user (like with a lanyard), carried from job to job.

Web SRL



Housing Hangs from *Anchor*

Mini PFL



Housing Hangs from *Worker's Back*

Small “personal fall limiters” (PFLs) have come about as a viable alternative to an energy-absorbing lanyard since they can be worn by the worker as they move around the jobsite, and they have the added benefit of expanding and contracting, depending on the length of line needed by the job.

- Often bring the worker to a ***stop in a matter of inches*** because of their quick locking action.

Larger SRLs are useful because they can come in lengths of well over 100 feet.

- May be used as fall protection for long vertical climbs when housing is attached at the top of the ladder.

4.2.2 Class A & Class B SRLs

Just as ANSI created updates for lanyards in recent years to reflect updates in technologies / increases in fall protection knowledge, it did so more recently with SRLs as well. Under the new system it listed two main styles of SRL and PFL, based on their “maximum arrest distance.”

SRL & PFL Classes – ANSI Z359.14–2014

Maximum Arrest Distance (MAD) – The total stopping distance of an SRL once a fall starts. It includes:

- The amount of line that pulls out before the device locks off – “Activation Distance”.
- The amount of line that pulls out after the brakes engage – “Deceleration Distance”.

We do not know the “Activation Distance” or the “Deceleration Distance” on their own; it is always given just as the “MAD”.

Class A SRL / PFL – Maximum Arrest Distance – 2 Feet (24”)

Class B SRL / PFL – Maximum Arrest Distance – 4 ½ Feet (54”)

4.2.3 Specialty SRLs & PFLs

4.2.3.1 Twin-Leg & Tie-Back PFLs



V-Tec PFL



V-Shock PFL



Workman Twin Tie-Back PFL

Just as there were twin-leg energy-absorbing lanyards, this is also an option with self-retracting lifelines. Specifically, the devices above allow the worker to practice 100% connection while in movement from one location to another. Here, there are some major advantages over the more traditional twin-leg lanyard:

PFL Twin-Leg Benefits over Lanyards

- **Size** – The devices are compact when not in-use, eliminating trip hazards.
- **Free Fall is Decreased** – Only the amount of line needed is extracted, meaning free fall is reduced.
- **Total Fall Distance is Decreased** – Because it is so fast-acting, these stop the worker faster than a lanyard can.

4.2.3.2 Self-Retracting Lifeline with Rescue (SRL-R)

Another type of retractable offers a feature unlike anything seen up to this point. Known as the Workman® Rescuer, it functions as an SRL in normal use but can be converted into a rescue tool if the worker falls into it. Although useful in a wide variety of different applications, it is commonly utilized by teams that are making entries into confined spaces where there is both a fall hazard and / or the potential for the worker to be overcome by an atmospheric hazard and need to be pulled out. This model incorporates a crank mechanism that may be activated to rescue (raise or lower) an attached person in an emergency.

Traditionally such units have been attached to what is known as a tripod. However, newer technologies allow it to be attached to other types of confined space “davits” or, if so desired, simply hung like any other SRL over a work area where a fall hazard exists, and extrication / rescue may become necessary.



Workman® Rescuer

4.2.3.3 Sealed SRLs

Sealed units such as the one shown to the right find work in environments that are very harsh such as in the Oil & Gas industry as well as in the salty ocean environment of offshore wind turbines. The important aspect with these units is that critical internal components that could be damaged by the harsh environments are completely sealed and kept away from them. This contrasts with traditional SRL’s where dirt, gunk, and salt spray can be retracted with the lifeline up into the unit where it all can affect critical components such as the line retention spring or the entire internal braking mechanism.



Sealed SRL

4.2.3.4 Leading Edge SRLs / PFLs (SRL-LE)

A “leading edge” SRL is one that has been designed to be able to withstand the forces of having its line bent over an edge when a worker falls. The reason that special designing needs to take place is because many SRLs store their energy-absorber capabilities in the housing.

What typically happens is that when the worker falls, their line (no matter the composition) bites into the edge:

- eliminating the ability of the energy-absorber to function; and
- severely stressing the line in the area of the bend.

While normal SRLs are not designed for this type of use, Leading Edge SRLs (SRL-LE) are designed specially to deal with this type of a fall.

1. **Line Protection** – A special protective cover is placed over the line and / or a larger, stronger line material is used.
2. **Added Energy-Absorber** – An additional energy absorber is put at the end of the line where the worker attaches into their harness. If the line bites in as described, this extra absorber begins to open to minimize force and protect the line.

These devices, because of the rigorous tests that they must pass, are specialized to tackle especially harsh situations where free fall is high due to low tie-off and where coming into contact with a sharp edge is likely. As with the other styles already covered, these also come in both SRL and smaller PFL versions.



20' Leading Edge SRL



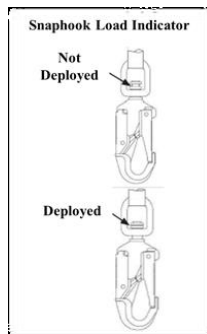
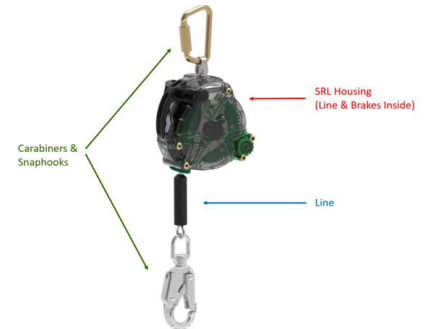
8' Twin-Leg Leading Edge PFL

4.2.4 Inspection & Maintenance

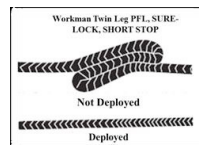
Inspecting an SRL will be straightforward already knowing the basic parameters that have been set forth for other pieces of equipment. However, due to some obvious differences, a few points need to be highlighted here while others are reviewed.

Hardware:

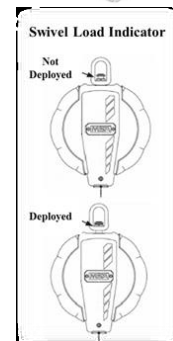
- Snaphooks / Carabiners – Corrosion-Free, Auto-Closing & Locking
- Top Swivel – No Cracks / Breaks, Swivels Correctly, All Rivets Tight
- Load Indicator – Verify not Deployed



Deployed Snaphook Load Indicator



Web & Latchways Load Indicators



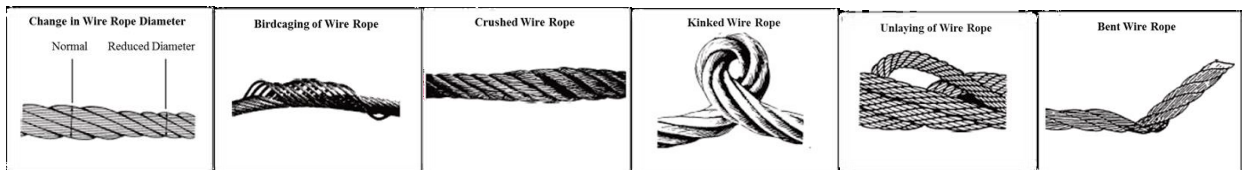
Deployed Swivel Load Indicator

Housing:

- Free of Cracks, Breaks, and Dents that Affect Operation (Spinning of the Internal Drum)
- Label – Present & Completely Legible

Lifeline:

For synthetic webbing or rope, inspect the entire length for any amount of damage anywhere along the line. For cable, wearing gloves and using a cloth, allow the line to retract in after having pulled it all out, checking for corrosion or breaks.



Make sure that the connection on the end of the line—be it a stitch with synthetic materials or a “swage” that holds the cable in a teardrop shape to form an eye—be unbroken and not loose.