Fall Protection - Fall Arrest Systems

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What is meant by fall arrest system?

Fall arrest system is the name given to the group of equipment, components, and systems used to arrest (stop) a fall from height. These systems can be used to protect workers who that are working at heights.

A fall arrest system should only be used when other methods of fall protection are not available or possible, including engineering controls (e.g., elevated platform), guardrails, safety nets, or travel restraint . Fall arrest systems should:

- keep the free fall distance as short as possible,
- minimize the forces of the fall experienced by the worker,
- protect the worker from striking other surfaces while falling, and
- protect the worker from the pendulum effect or swing falls.

See other OSH Answers documents for more information on fall protection, including fall protection plan.

Always use the type of fall arrest system(s) required by your local jurisdiction, and standards such as CSA Z259.17 “Selection and use of active fall-protection equipment and system”, Z259.12 “Connecting components for personal fall arrest systems”, Z259.16 “Design of active fall-protection systems”, and others.

NOTE that other requirements may be needed that are not discussed in this document. Always consult the legislation that applies in your situation, and with your jurisdiction for complete information.

What should be considered when using a fall arrest system?

It is important to assess the hazards a worker may be exposed to if they fall, and the impact of the fall arrest system itself. Three key elements include:

- **bottoming out** - the term used when a worker may hit the ground, or any material, equipment, or a lower level of the structure before the fall is arrested
- **pendulum effect** - also known as swing fall, occurs when the worker swings from side to side while falling, and there is the possibility the worker will hit equipment, material, or a structure while swinging
- **suspension trauma** – also known as orthostatic intolerance, this injury occurs when a worker is suspended. While they remain suspended (hanging), their blood will pool in their legs and consequently reduce the amount of oxygen available to the brain.

Fall arrest systems may be affected by conditions that reduce the falling speed, such as sliding down a slope, or sinking into loose material (such as fine granules, or free flowing solid).

Always use the appropriate types of equipment to match the other components present (such as wire rope, synthetic rope, cable, or rail arresters).

All equipment or systems must be inspected before use, and if any issues are noted, a competent person should determine if it should be used, repaired, or removed from service.

How can bottoming out be prevented?

To prevent bottoming out, the fall arrest system should be designed to minimize the free fall distance.

To determine the total fall clearance distance, consider the following elements:

- length of the lanyard

- length of the energy absorber when it is deployed (when in use)
- length of the harness and other equipment when stretched
- the location and strength of the anchor point
- the worker's height
- the vertical (up and down) and horizontal (side-to-side) clearances
- the potential for pendulum or swing falls
- a safety factor distance

How is the total fall clearance distance calculated?

Total fall clearanxcce distance is the distance from the ground (or object below) to the connection point where the worker attaches their lanyard to the anchor or lifeline.

To prevent bottoming out, the fall clearance distance must be longer than the distance the worker could fall before being stopped by the fall arrest system. When calculating the fall clearance distance, consider the length of the lanyard, the length of the energy absorber (when deployed), the worker's height, and a safety factor.

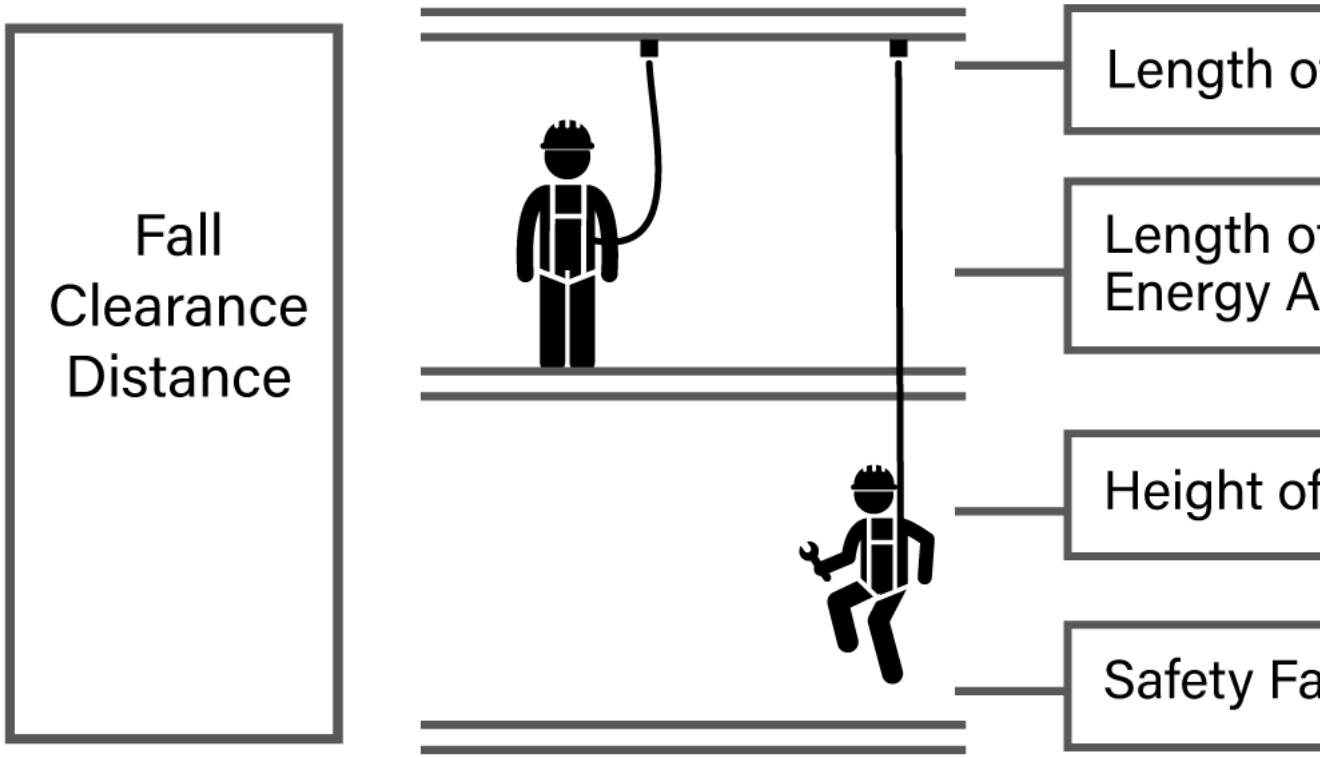

Figure 1: Elements used to calculate the fall clearance distance (adapted from Infrastructure Health and Safety Association, 2020)

Detailed equations are available, including those in CSA Z259.17 "Selection and use of active fall-protection equipment and system". The manufacturer of the fall arrest equipment or a fall protection training organization may also have recommendations.

Note: Certain CSA Group standards are available for online viewing. To access these, you must first create an account with "CSA Communities".
Go to: https://community.csagroup.org/login.jspa?referer=%252Findex.jspa
Once you are logged in, click on the text below the "OHS Standards / View Access" graphic.
Click on the jurisdiction of your choice to see the CSA Standards as referenced in that legislation. Standards may also be purchased from CSA Group: https://store.csagroup.org/

What is the pendulum effect and how to reduce it?

The pendulum effect, or swing fall, occurs when a worker swings from side to side after the fall has been arrested. When there is swing, there is a danger of the worker hitting the ground (vertical impact), or equipment, materials, or the structure (horizontal impacts). The greater the swing, the harder the worker will hit objects in their path. The swinging movement may also cause the lanyard or lifeline to break when these lines are in contact with rough or sharp edges.

To reduce swinging, the anchor point should be directly above the worker. Options also include to use a second anchor point at the same time, change anchor points to keep the lanyard or lifeline perpendicular (directly above) as work progresses, or use a horizontal lifeline, where appropriate.

What is suspension trauma and how to address it?

Suspension trauma, also known as orthostatic intolerance, occurs when a worker is suspended. While they remain suspended (hanging), the worker may not be able to move, and the pressure from their body weight against the harness will result in the blood pooling in their legs. As a result, there will be less blood (and oxygen) available to the brain. Light-headedness, nausea, unconsciousness, serious injury, or death may result. Delayed effects may include kidney failure. Workers with head injuries or who are unconscious are more likely to experience severe health effects.

An effective rescue plan will outline the procedures needed to rescue suspended workers as quickly as possible.

While a worker is suspended, a relief strap or a loop tied to the harness that a worker can put their feet into may help relieve the pressure. These measures will not be helpful if the worker is unconscious (from the fall, or from suspension trauma). Workers waiting to be rescued can also try to “pump” their legs often to help activate the muscles needed to move blood throughout the body.

If the worker becomes unconscious, keep the worker’s airways open and get first aid.

Any worker who has fallen should be taken to a hospital for examination. Tell the emergency medical staff how long the worker had been suspended in mid-air. Ask the medical staff to monitor for kidney failure.

Fact sheet last revised: 2023-01-25

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