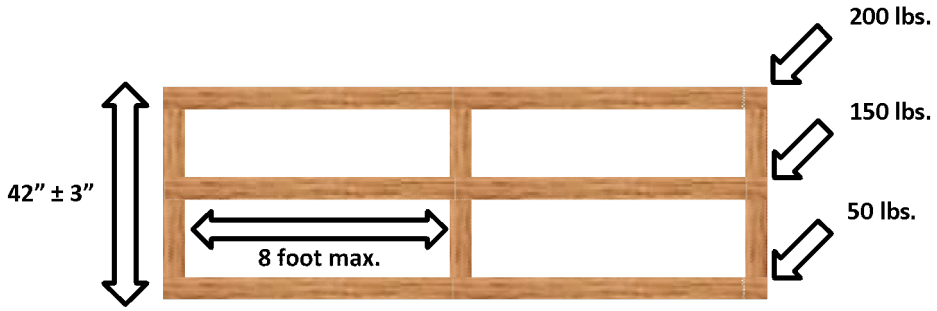
MODULE 3 – FALL PREVENTION SYSTEMS

Learning Objectives

- Explain the requirements for building guardrail system
- Describe the safety net system
- Describe the different types of fall prevention
- Define the different parts of a fall restraint system
- Describe positioning device systems

Guardrail Systems

"Guardrail system" means a barrier erected to prevent employees from falling to lower levels. Guardrail systems and their use shall comply with the following provisions:



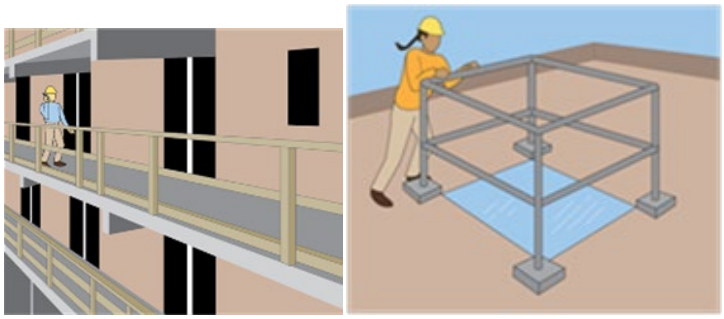
NOTE: The 8 foot maximum pictured above is a non-mandatory requirement.

A guardrail system consists of a toprail, midrail and toe board.

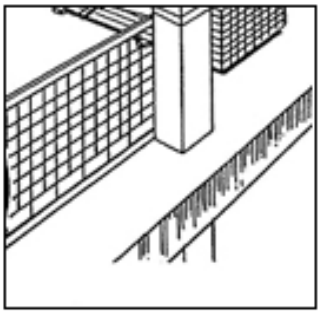
- If wire rope is used for toprails, it must be flagged at not more 6 feet intervals with high-visibility material. Wire rope guardrails must be at least one-quarter inch (0.6 centimeters) nominal diameter or thickness to prevent cuts and lacerations.
- All guardrail systems must be smooth surfaced.

NOTE: Steel and plastic banding cannot be used as toprails or midrails.

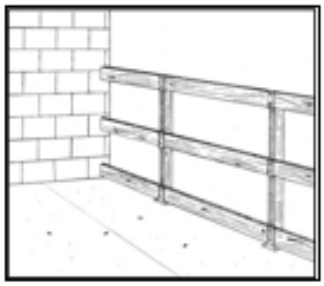
NOTE: Manila, plastic, or synthetic rope used for toprails or midrails must be inspected as frequently as necessary to ensure strength and stability.



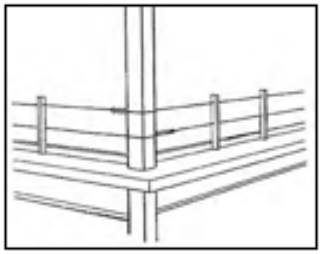
Screens/Mesh



Top Rail – Mid Rail – Toe Board



Wire Rope



Balusters

Additional requirements for guardrails:

- Guardrail system must be capable of withstanding a force of at least 200 pounds applied within 2 inches of the top edge in any outward or downward direction. When the 200 pounds test is applied in a downward direction, the top edge of the guardrail must not deflect to a height less than 39 inches above the walking/working level.
- Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members shall be capable of withstanding a force of at least 150 pounds applied in any downward or outward direction at any point along the midrail or other member.
- Toeboards shall be capable of withstanding, without failure, a force of at least 50 pounds applied in any downward or outward direction at any point along the toeboard. *"Toeboard"* means a low protective barrier that will prevent the fall of materials and equipment to lower levels and provide protection from falls for personnel.

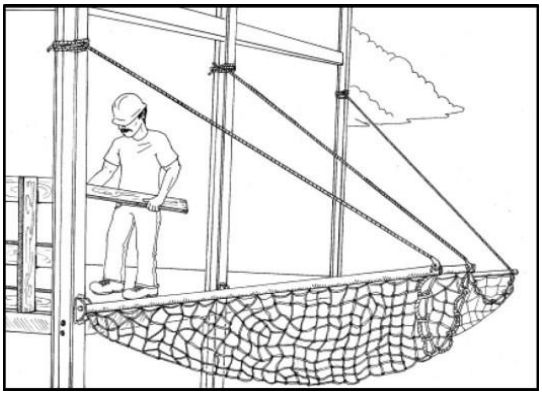
Basic guardrail components come in a variety of materials and configuration options. It is common for employers to use material available or produced at the worksite. Upright supports may be made from wood, formed metal, pipe, or composites. Wire rope is sometimes used for the top rails and midrails.

Temporary Guardrails

Premade or job-made guardrails can be used as temporary guardrails while more permanent structures are being installed or when the work is transient or in a space not intended as a permanent work area. For example, temporary guardrails can be used while constructing a wall, completing floor decking, or replacing a

roof. These guardrails are often constructed from reusable materials or premade guardrail system components.

Premade guardrails are particularly susceptible to damage if not handled properly when disassembled and stored. Specific handling instructions are typically included in the manufacturer's recommended procedures for disassembling and storing the guardrail components. If railing components are bent, broken, or missing, the guardrail may not be effective. Damage is more likely to occur if the components are dropped when disassembled, transported in vehicles, or stored in areas not protected from conditions that could cause corrosion or distortion.



Safety Net Systems

Safety net systems and their use shall comply with the following provisions:

- Safety nets systems must be installed as close as practicable under the walking/working surface on which employees are working, but in no case more than 30 feet below such level. When nets are used on bridges, the potential fall area from the walking/working surface to the net shall be unobstructed.
- Safety nets shall be installed with sufficient clearance under them to prevent contact with the surface or structures below when subjected to an impact force.
- Defective nets shall not be used. Safety nets shall be inspected at least once a week for wear, damage, and other deterioration. Defective components shall be removed.

from service. Safety nets shall also be inspected after any occurrence which could affect the integrity of the safety net system.

- Materials, scrap pieces, equipment, and tools which have fallen into the safety net shall be removed as soon as possible from the net and at least before the next work shift.
- The maximum size of each safety net mesh opening shall not exceed 36 square inches nor be longer than 6 inches on any side, and the opening, measured center-to-center of mesh ropes or webbing, shall not be longer than 6 inches.
- Each safety net (or section of it) shall have a border rope for webbing with a minimum breaking strength of 5,000 pounds.

Safety nets shall extend outward from the outermost projection of the work surface as follows:

Vertical distance from working level to horizontal plane of net.	**Minimum required horizontal distance of outer edge of net from the edge of the working surface.**
Up to 5 feet	**8 feet**
More than 5 feet up to 10 feet	**10 feet**
More than 10 feet	**13 feet**

NOTE: See 29 CFR 1926.502(c) for additional requirements on safety net systems.

In some situations, safety nets can be placed underneath unsheathed trusses to prevent workers from falling between the trusses to the level below. Safety nets must be installed to prevent contact with the surface or structures below them. For requirements for safety nets, refer to 29 CFR 1926.502(c).

Walking / Working Surfaces

Each employee on walking/working surfaces must be protected from tripping in or stepping into or through holes (including skylights) by personal fall arrest systems, covers, or guardrail systems erected around such holes.

Employees are to also be protected from stepping in or tripping over holes where there is no hazard of falling all the way through the hole. In general, if the opening meets the definition of a hole it must be protected.

Walking/Working Surfaces Strength and Integrity

The employer must determine if the walking/working surfaces on which its employees are to work have the strength and structural integrity to support the employees safely. Employees must only be allowed to work on any surface only when it has been determined that it is safe to do so. Examples of walking/working surfaces that need to be evaluated:

Roofs & Roofing Supports
Hole Covers (including Skylights) Scaffolds & Shoring
Piping Systems Stairways & Ladders
Formwork & Reinforcing Steel
Ramps, Runways, and other Walkways
Concrete Columns & Structures
Steel & Metal Decking
Sidewalks, Pavements, and other Appurtenant Structure

Holes

"Hole" means a gap or void 2 inches or more in its least dimension, in a floor, roof, or other walking/working surface.

- Hole Covers
    - Cover or guard floor holes as soon as they are created during new construction.
    - For existing structures, survey the site before working and continually audit as work continues. Guard or cover any openings or holes immediately.
    - Construct all floor hole covers so they will effectively support two times the weight of employees, equipment, and materials that may be imposed on the cover at any one time.
    - Secure all floor hole covers to prevent accidental displacement by the wind, equipment, or employees. All covers shall be color or they shall be marked with the word **"Hole" or "Cover."**

Effective Hole Covers

Covers are strong protective surfaces used on walking/working surfaces or roadways to prevent workers from falling through a hole.

Covers for permanent holes are typically built for a specific purpose (e.g., permanent access points, manhole covers, and trap doors) and are only effective when they are properly designed and secured in place.

Covers for temporary holes are often constructed on work sites with reusable materials, most commonly using plywood and steel plates. For example, to cover large holes in a road, hinged steel plate covers can be used. Other options for covers include grates designed to support weight, custom boxes to cover a hole with an elevated lip or partially installed equipment, and temporary trapdoors.

Effective hole covers are:

- Large enough to provide appropriate overlap to prevent workers from falling through.
- Strong enough to support at least twice the anticipated weight imposed by the heaviest load.
- Left in place over the hole until access is needed.
- Inspected periodically to identify deterioration.
- Secured and do not create trip hazards.
- Clearly marked as hole covers.

The following materials lack the strength necessary to prevent a worker from falling through a hole:

- Cardboard;
- Tarps;
- Materials not intended to bear the anticipated load (e.g., plastic or glass);
- Loose materials that could separate (e.g., unsecured two-by-four planks);
- Damaged materials (e.g., deteriorating wood, a bent metal plate);
- Drywall or particle board; and
- Chicken wire or other fencing material.

Plywood Hole Covers

Heavy plywood is a common choice for covering temporary holes in floors and roofs (see Figure 9), but plywood strength and durability can vary. Some materials, including plywood scraps from shipping crates or similar scrap products, do not have structural value or span ratings, making it hard to know if they are strong enough. In addition, strength information on the plywood is occasionally covered with paint.

Plywood Strength Rating Systems

Several factors determine and measure plywood strength. In the United States, two groups provide the most commonly used plywood rating systems: APA–The Engineered Wood Association (formerly the American Plywood Association and Douglas Fir Plywood Association) and the Timber Engineering Company (TECO). Refer to these organizations for detailed information on plywood strength ratings. The

hole size and the expected load weight are considered when determining if the plywood is effective for use as a hole cover.

Plywood Strength and Durability

Plywood is susceptible to damage over time from exposure to water, traffic, and heavy loads that may reduce its strength. Some indicators of reduced-strength plywood may include cracks, chips, a warped appearance, a worn surface, de-lamination, and water stains. Expected damage after exposure to water depends on whether the plywood is exterior-grade or interior-grade. The binding agents (i.e., adhesive) used to adhere interior-grade plywood layers degrade more rapidly in a moist environment than do the binders used in exterior-grade plywood.

When workers are using hauling equipment, the weight of the equipment and its load is concentrated into the smaller area that contacts the ground (e.g., the load in a wheelbarrow will concentrate where the wheel hits the ground – an area of just a few inches in size). Commonly used routes for hauling these loads will experience additional wear and tear to the flooring. Adding a protective layer to the floor along these routes is one way to prevent damage to the flooring from concentrated loads. Typical protective layers may include liquid latex compounds, penetrating oils, sheet plastics, and interlocking membranes.

Plywood Cover Size and Orientation

The plywood cover's size and orientation can affect the cover's overall effectiveness. Plywood covers rest on the hole edges that are supported through the joists. The following are indications that a plywood cover's size and orientation will generally keep workers from falling through a hole:

- The plywood piece is larger than the hole size so that it is possible to cover the hole with the shortest panel side overlaying the longest unsupported hole dimension.
- The panel overlaps the supporting surfaces around the hole far enough for needed support.
- The panel is positioned with the strength axis (grain direction) running along the shortest unsupported hole dimension.

Protection from Falling Objects

Protection from falling objects require -Toeboards, erected along the edge of the overhead walking/working surface for a distance enough to protect employees below and capable of withstanding, without failure, a force of at least 50 pounds applied in any downward or outward direction at any point along the toeboard.

Toeboards are minimum of 3 1/2 inches in vertical height from their top edge to the level of the walking/working surface. No more than 1/4 inch clearance above the walking/working surface. They must be solid or have openings not over 1 inch in greatest dimension.

Where tools, equipment, or materials are piled higher than the top edge of a toeboard, paneling or screening shall be erected from the walking/working surface or toeboard to the top of a guardrail system's top rail or midrail, for a distance enough to protect employees below.

Guardrail systems openings must be small enough to prevent passage of potential falling objects.

During the performance of overhand bricklaying and related work: No materials or equipment except masonry and mortar shall be stored within 4 feet of the working edge. Excess mortar, broken or scattered masonry units, and all other materials and debris must be kept clear from the work area by removal at regular intervals.

During the performance of roofing work: Materials and equipment must NOT be stored within 6 feet of a roof edge unless guardrails are erected at the edge. Materials which are piled, grouped, or stacked near a roof edge shall be stable and self-supporting.

Canopies must be strong enough to prevent collapse and to prevent penetration by any objects which may fall onto the canopy.

Warning Line Systems

The warning line shall be erected around all sides of the roof work area. When mechanical equipment is not being used, the warning line shall be erected not less than 6 feet from the roof edge. When mechanical equipment is being used, the warning line shall be erected not less than 6 feet and not less than 10 feet from the roof edge.

Points of access, materials handling areas, storage areas, and hoisting areas shall be connected to the work area by an access path formed by two warning lines. Place a warning line system across the path at the point where the path intersects the warning line erected around the work area, or the path shall be offset such that a person cannot walk directly into the work area.

The rope, wire, or chain shall be:

- flagged at not more than 6-foot intervals with high- visibility material;
- no less than 34 inches and more than 39 inches from the walking/working surface.

After being erected, the warning line shall be:

- capable of resisting, without tipping over, a force of at least 16 pounds applied horizontally;
- 30 inches above the walking/working surface;
- perpendicular to the warning line, and in the direction of the floor, roof, or platform edge; and
- a minimum tensile strength of 500 pounds.

Controlled Access Zone (CAZ)

A controlled access zone is a clearly marked, designated work area where certain work (e.g., overhand bricklaying) may take place without conventional fall protection systems. Controlled access zones are used to keep out workers other than those authorized to enter a work area.

Situations where CAZs are used:

- Overhand bricklaying and related work (see 29 CFR 1926.501(b)(9));
- Leading edge work (see 29 CFR 1926.501(b)(2); 29 CFR 1926.502(k)(7));
- Residential construction (see 29 CFR 1926.501(b)(13); 29 CFR 1926.502(k)(7)); and
- Precast concrete erection (see 29 CFR 1926.501(b)(12); 29 CFR 1926.502(k)(7)).

In overhand bricklaying and related work, CAZs can be used provided that workers are not reaching more than 10 inches below the walking or working level they are on (see 29 CFR 1926.501(b)(9)).

CAZs may be used for leading edge work, precast concrete work, and residential construction work only as part of a fall protection plan when conventional fall protection is infeasible or creates a greater hazard (see 29 CFR 1926.501(b)(2)(i), (b)(12), (b)(13); 29 CFR 1926.502(k)).

Control Lines Used in a CAZ

Control lines are erected not less than 6 feet nor more than 25 feet from the unprotected or leading edge, except when erecting precast concrete members. When erecting precast concrete erect not less than 6 feet nor more than 60 feet or half the length of the member being erected, whichever is less, from the leading edge.

The control line must be connected on each side to a guardrail system or wall at 39 inches from the walking/working surface and its highest point at 45 inches. Each line shall have a minimum breaking strength of 200 pounds.

The control line shall extend along the entire length of the unprotected or leading edge and shall be approximately parallel to the unprotected or leading edge. The control line shall be connected on each side to a guardrail system or wall.

When used to control access to areas where overhand bricklaying and related work are taking place: The controlled access zone shall be defined by a control line erected not less than 10 feet (3.1 m) nor more than 15 feet (4.5 m) from the working edge. The control line shall extend for a distance sufficient for the controlled access zone to enclose all employees performing overhand bricklaying and related work at the working edge and shall be approximately parallel to the working edge. Additional control lines shall be erected at each end to enclose the controlled access zone. Only employees engaged in overhand bricklaying or related work shall be permitted in the controlled access zone (29 CFR 1926.502(g)(2)).

Control lines shall consist of ropes, wires, tapes, or equivalent materials, and supporting stanchions as follows: Each line shall be flagged or otherwise clearly marked at not more than 6-foot (1.8 m) intervals with high-visibility material. Each line shall be rigged and supported in such a way that its lowest point (including sag) is not less than 39 inches (1 m) from the walking/working surface and its highest point is not more than 45 inches (1.3 m) [50 inches (1.3 m) when overhand bricklaying operations are being performed] from the walking/working surface. Each line shall have a minimum breaking strength of 200 pounds (.88 kN) (29 CFR 1926.502(g)(3)).

Controlled Decking Zone (CDZ)

A controlled decking zone is a clearly marked work area used during steel erection while workers are initially

installing decking at the leading edge of the work area 15 feet and up to 30 feet above a lower level. The boundaries of a CDZ must be designated and clearly marked at 90 feet wide and 90 feet deep from any leading edge.

Safety Monitoring Systems

Safety monitoring systems must designate a competent person to monitor the safety of other employees and the employer must ensure that the safety monitor:

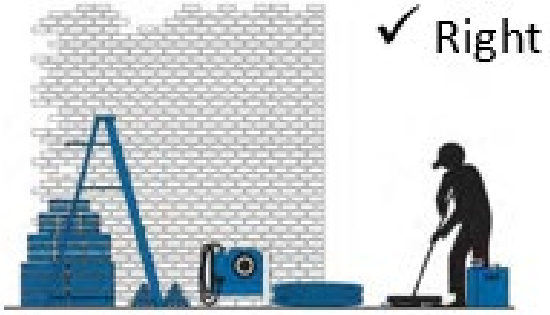
- Recognize fall hazards;
- Warn the employee when it appears that the employee is unaware of a fall hazard or is acting in an unsafe manner;
- The safety monitor shall be on the same walking/working surface and within visual sighting distance of the employee being monitored;
- The safety monitor shall be close enough to communicate orally with the employee; and
- The safety monitor shall not have other responsibilities which could take the monitor's attention from the monitoring function.

Safety monitoring systems are typically used as part of fall protection plans during precast concrete erection work, leading edge work, and residential construction work when conventional fall protection is infeasible or would create a greater hazard and alternative measures (such as scaffolds, ladders, or vehicle mounted work platforms) are not used (see 29 CFR 1926.501(b)(2), (b)(12), (b)(13); 29 CFR 1926.502(k)(6), (k)(8)). Also, when conducting roofing work on a flat or low sloped roof that is 50 feet or less in width, a safety monitoring system may be used as a stand-alone fall protection technique.

Only workers engaged in low-sloped roofing work and workers performing the specific job tasks covered by a fall protection plan are allowed in an area where workers are being protected by a safety monitoring system. As stated before, the worker designated as the safety monitor may not perform other job tasks that could take attention away from the monitoring function.

Housekeeping

During construction, alteration, or repairs, form and scrap lumber with protruding nails, and all other debris, must be kept cleared from work areas, passageways, and stairs, in and around buildings or other structures.

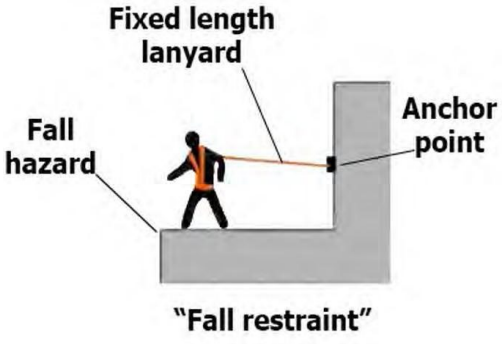


Fall Protection Plans

The fall protection plan is prepared by a **qualified person** and developed specifically for the site where the leading-edge work, precast concrete work, or residential construction work is being performed and the plan must be maintained up to date.

A fall protection plan is created when its infeasible or conventional fall protection equipment creates a greater hazard to use. Any changes to the fall protection plan shall be approved by a qualified person.

- A copy of the fall protection plan with all approved changes shall be maintained at the job site.
- The implementation of the fall protection plan shall be under the supervision of a competent person.
- The fall protection plan shall document the reasons why the use of conventional fall protection systems (guardrail systems, personal fall arrest systems, or safety nets systems) are infeasible or why their use would create a greater hazard.
- The fall protection plan shall include a written discussion of other measures that will be taken to reduce or eliminate the fall hazard for workers who cannot be provided with protection from the conventional fall protection systems. For example, the employer shall discuss the extent to which scaffolds, ladders, or vehicle mounted work platforms can be used to provide a safer working surface and thereby reduce the hazard of falling.
- The fall protection plan shall identify each location where conventional fall protection methods cannot be used. These locations shall then be classified as controlled access zones and the employer must comply with the criteria in paragraph (g) of this section.
- Where no other alternative measure has been implemented, the employer shall implement a safety monitoring system in conformance with 1926.502(h).
- The fall protection plan must include a statement which provides the name or other method of identification for each employee who is designated to work in controlled access zones. No other employees may enter controlled access zones.
- In the event an employee falls, or some other related, serious incident occurs, (e.g., a near miss) the employer shall investigate the circumstances of the fall or other incident to determine if the fall protection plan needs to be changed (e.g. new practices, procedures, or training) and shall implement those changes to prevent similar types of falls or incidents.



Restraint Systems

A restraint system prevents a worker from being exposed to any fall. If the employee is protected by a restraint system, either a body belt or harness may be used. When a restraint system is used for fall protection from an aerial lift or a boom-type elevating work platform, the employer must ensure that the lanyard and anchor are arranged so that the employee is not potentially exposed to falling any distance.

While fall restraint systems aren't mentioned in OSHA's fall protection rules, OSHA will accept a properly utilized fall restraint system in lieu of a personal fall arrest system when the restraint system is rigged so that the worker cannot get to the fall hazard and the fall restraint systems should have the capacity to withstand at least 3,000 pounds of force or twice the maximum expected force that is needed to restrain the worker from exposure to the fall hazard.

In effect, (if properly used) the system tethers a worker in a manner that will not allow a fall of any distance. A fall restraint system is comprised of a body belt or body harness, an anchorage, connectors, and other necessary equipment. Other components typically include a lanyard and may also include a lifeline and other devices.

Positioning Device Systems

This system holds the worker in place while keeping his/her hands-free to work. Whenever the worker leans back, the system is activated. However, the personal positioning system is not specifically designed for fall arrest purposes. The only time a body belt may be used where there may be a fall is when an employee is using a "positioning device."

A positioning device system is defined as a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall (or a pole), and work with both hands free while leaning. Therefore, 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. They may be used in concrete form work, installation of reinforcing steel, and certain telecommunications work. Since construction workers in bucket trucks, scissor lifts and boom-type elevating work platforms are on a **horizontal** surface, a positioning device may not be used for those workers.

Module 3 Key Take-aways

- A toprail of the guardrail is 42 inches high.
- Guardrail system must be capable of withstanding a force of at least 200 pounds.
- Toeboards shall be capable of withstanding, without failure, a force of at least 50 pounds.
- A hole is anything bigger than 2 inches.
- Color-code all covers or mark with the word **"Hole" or "Cover."**
- The warning line shall be erected around all sides of the roof work area at 6 feet.
- Flagged are placed at 6-foot intervals with high- visibility material.
- A restraint system prevents a worker from being exposed to any fall.
- A positioning device system is body harness system rigged to allow an employee to be supported on an elevated vertical surface only.
- Positioning device systems permit a fall of up to 2 feet.