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MODULE 3: FALL PREVENTION SYSTEM

Overview

- How do you build a guardrail system?
- What is a safety net system?
- What different types of fall prevention can be used?
- What are the different parts of a fall restraint system?
- What are positioning device systems?

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Upon completion of this module you will be able to:

* 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

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Guardrail Systems

- A guardrail system can be used as a barrier installed to prevent workers from falling off a work surface edge to a lower level
- Guardrails can also be used to keep workers from falling into holes or openings in decking or floors
- Guardrails are typically constructed using:
  - Upright supports attached to the working surface;
  - A horizontal top rail connected to the supports;
  - One or more midrails running parallel to the toprail; and
  - Toeboards when necessary to protect workers below from falling objects.

Introduce basic requirements of guardrail systems.

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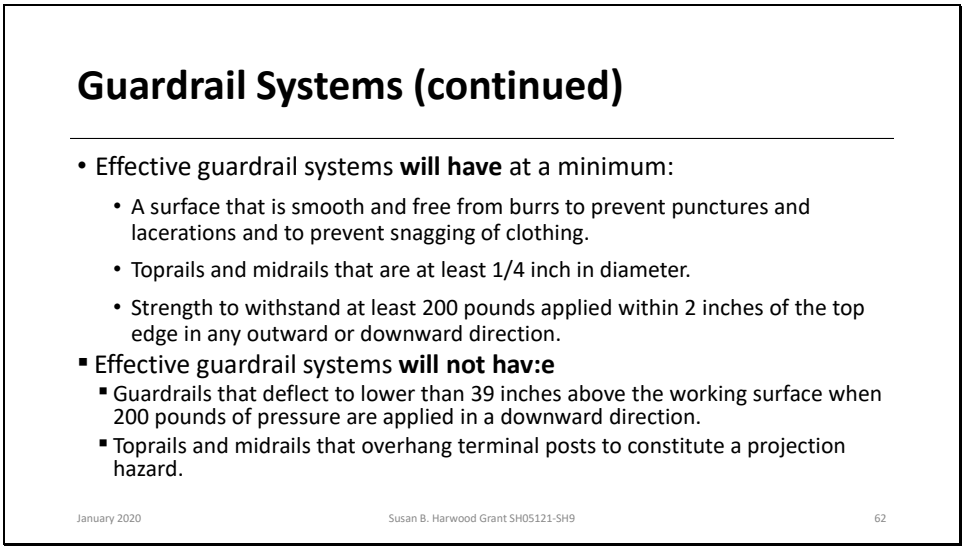

Effective guardrail systems will have at a minimum:

- A surface that is smooth and free from burrs to prevent punctures and lacerations and to prevent snagging of clothing (see 29 CFR 1926.502(b)(6)).
- Toprails and midrails that are at least 1/4 inch in diameter (see 29 CFR 1926.502(b)(9)).
- Strength to withstand at least 200 pounds applied within 2 inches of the top edge in any outward or downward direction (see 29 CFR 1926.502(b)(3)).

Effective guardrail systems **will not have**

- Guardrails that deflect to lower than 39 inches above the working surface when 200 pounds of pressure are applied in a downward direction.
- Toprails and midrails that overhang terminal posts to constitute a projection hazard.

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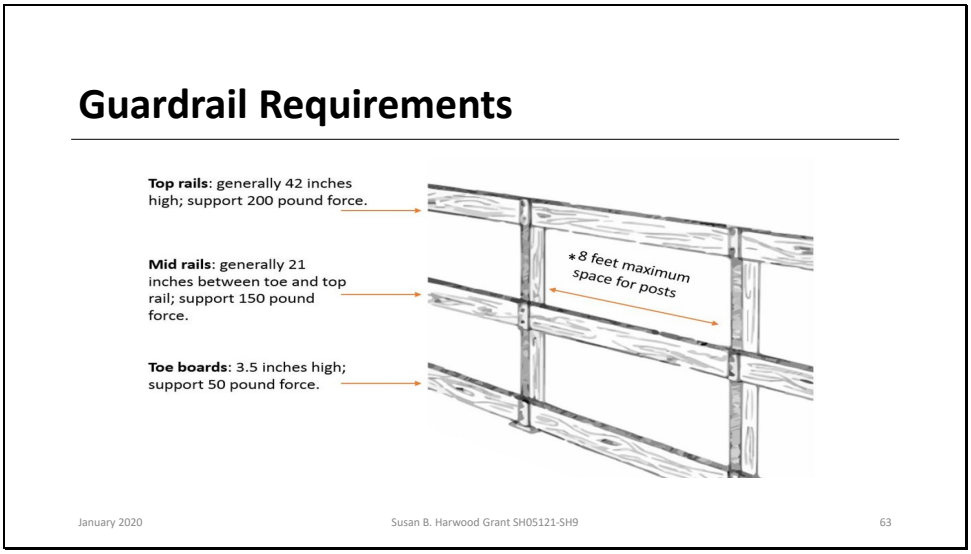

More guardrail requirements:

* A toprail between 39 and 45 inches from the working level, raised as necessary to account for workers using stilts or otherwise working in an elevated location above the work surface (see 29 CFR 1926.502(b)(1)).
* Midrails (or equivalent structural members) that withstand at least 150 pounds of force in the downward or outward direction (see 29 CFR 1926.502(b)(5)).
* A midrail, mesh, screen, or equivalent intermediate structural members installed between the guardrail system top edge and the walking/working surface when there is no wall or parapet wall at least 21 inches high (see 29 CFR 1926.502(b)(2)).
* Intermediate members (such as balusters), when used between posts, that are not more than 19 inches apart (see 29 CFR 1926.502(b)(2)(iii)).
* Flags made of high visibility material every 6 feet if wire rope is used for top rails

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.

These are guidelines as a starting point for designing guardrail systems. However, the guidelines do not provide all the information necessary to build a complete system. The components of a guardrail system must still be designed and assembled in such a way that the completed system meets all applicable requirements.

Workers installing or removing guardrails must be protected using other forms of fall protection whenever the guardrail systems are not attached securely to a stable structure

NOTE: *8 feet maximum space for posts is based on non-mandatory standards

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Temporary Guardrails

- Premade or job-made guardrails can be installed for temporary use.
- 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.

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 (see Figure 4). These guardrails are often constructed from reusable materials or premade guardrail system components as shown in Figure 4 (see 29 CFR 1926.502(b)).

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.

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Temporary Guardrails (continued)

- Premade guardrails are particularly susceptible to damage.
- 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.

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Temporary Guardrails

- Premade guardrails are particularly susceptible to damage if not handled properly when disassembled and stored.
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- 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.

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Other Guardrails

- Guardrails for Scaffolds, Aerial Lifts, and Scissor Lifts
- Stairrails and Handrails
- Hole Covers

Briefly mention these special types of guardrails. They are not included in the student text.

Guardrails for Scaffolds, Aerial Lifts, and Scissor Lifts
Guardrails, possibly in combination with additional types of fall protection systems (e.g., PFAS or restraint system), may be used to address these hazards (see 29 CFR 1926.451(g)(1); 29 CFR 1926.453(b)(2)(v); 29 CFR 1926.954(b)(3)(iii)(A)).

Stairrails
A stairrail system is a vertical barrier that runs along the unprotected side edge of a stairway to prevent workers from falling to lower levels (see Figures 5 and 6). The top surface of the stairrail system may be used as the handrail (see 29 CFR 1926.1050(b); 29 CFR 1926.1052(c)(7)).

Handrails
Effective handrails provide an adequate handhold for workers to grasp to prevent them from falling (see Figure 6 and 29 CFR 1926.1052(c)(1), (c)(9)).

Effective handrails are 30 to 37 inches high and meet the guardrail strength requirements (i.e., able to withstand 200 pounds of weight applied within two inches of the top edge in any downward or outward direction at any point along the top edge) (see 29 CFR 1926.1052(c)(5), (c)(6)).

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Safety Net Systems

- Safety net systems are an option when workers are working at elevated heights with hazardous vertical drops.
- Safety net systems are commonly used during work on bridges and large structures.

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

Safety nets shall be installed as close as practicable under the walking/working surface on which employees are working, but in no case more than 30 feet (9.1 m) 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 (230 cm) nor be longer than 6 inches (15 cm) on any side, and the opening, measured center-to-center of mesh ropes or webbing, shall not be longer than 6 inches (15 cm).

Each safety net (or section of it) shall have a border rope for webbing with a minimum breaking strength of 5,000 pounds (22.2 kN).

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Safety Net System Dimensions

Vertical Distance from Working Level to Horizontal Plane of Net	Minimum Required Horizontal Distance of Outer Edge of Net from Edge of Working Surface
Up to 5 feet	8 feet
More than 5 feet, up to 10 feet	10 feet
More than 10 feet, up to 30 feet	13 feet
More than 30 feet	Safety net not permitted as fall protection
(See: 29 CFR 1926.502(c)(1), (c)(2))	

Discuss dimension requirements for safety nets.

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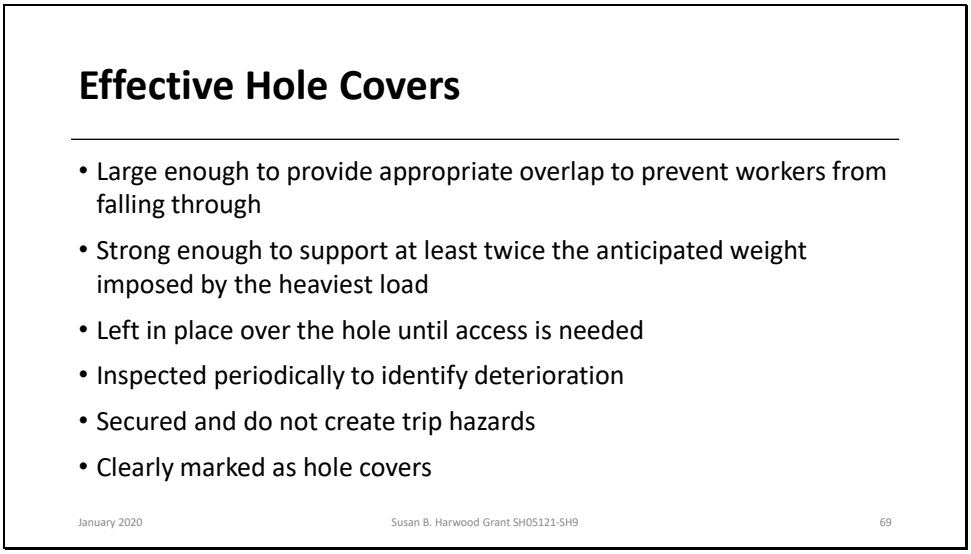

Effective Hole Covers

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. 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 (see 29 CFR 1926.502(i)(1), (i)(2)).
- Left in place over the hole until access is needed.
- Inspected periodically to identify deterioration.
- Secured (see 29 CFR 1926.502(i)(3)) and do not create trip hazards.
- Clearly marked as hole covers (see 29 CFR 1926.502(i)(4)).

The following materials lack the strength necessary to prevent a worker from falling through a hole (see 29 CFR 1926.502(i)(1), (i)(2)):

- 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.

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Hole Covers

- Heavy plywood is a common choice for covering temporary holes in floors and roofs, but plywood strength and durability can vary.
- All covers shall be color coded or they shall be marked with the word “Hole” or “Cover.”

Discuss the use of plywood hole covers and marking requirements for hole covers.

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Hole Covers

- Cover or guard floor holes as soon as they are created during new construction.
- For existing structures, survey the site and continually audit, covering openings or holes immediately.
- Construct all floor hole covers to effectively support 2x maximum weight.
- Secure all floor hole covers to prevent accidental displacement by the wind, equipment, or employees.
- Color code or mark all hole covers.

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 coded or they shall be marked with the word “Hole” or “Cover”.

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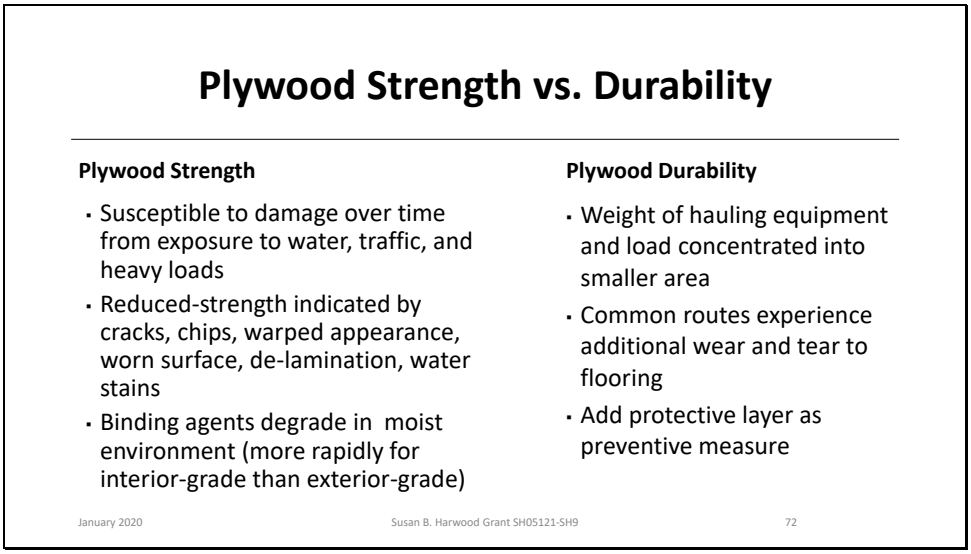

Plywood Strength Rating Systems
Several factors determine and measure plywood strength. In the United States, two groups provide the most commonly used plywood rating systems: APA–The Engineered Wood Association (formerly the American Plywood Association and Douglas Fir Plywood Association) and the Timber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

The hole size and the expected load weight are considered when determining if the plywood is effective for use as a hole cover (see 29 CFR 1926.501(b)(4); 29 CFR 1926.502(i)(1), (i)(2)).

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. For specific cases, SLTC, in conjunction with the U.S. Forest Service Products Laboratory, can evaluate plywood strength degradation.

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.

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Plywood Cover Size and Orientation

- 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.

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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

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Protection From Falling Objects

- Protection from falling objects require Toeboards that:
  - Withstand force of at least 50 pounds.
  - Are a minimum of 3 1/2 inches in vertical height.
  - Are solid or have openings not over 1 inch in greatest dimension.
- Guardrail systems openings must be small enough to prevent passage of potential falling objects.
- Materials and equipment must NOT be stored within 6 feet of a roof edge unless guardrails are erected at the edge.
- Canopies must be strong enough to prevent collapse and to prevent penetration by any objects which may fall onto the canopy.

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 sufficient 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 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.

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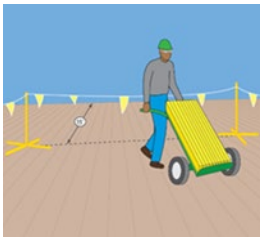
Warning Or Marking Systems

- Warning Line Systems
  - A warning line system is a barrier erected on a flat or low- sloped roof to warn workers that they are approaching an unprotected roof side or edge.



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A warning line system is a barrier erected on a flat or low- sloped roof to warn workers that they are approaching an unprotected roof side or edge (see 29 CFR 1926.500(b); 29 CFR 1926.501(b)(10); Figure 11). A warning line system includes a line (rope, wire, or chain) and supporting stanchions (see 29 CFR 1926.502(f)(2)).

Warning lines are not engineered to physically prevent or arrest falls and may not be used in all situations. On flat or low-sloped roofs, warning lines are used in conjunction with conventional fall protection or a safety monitoring system (see 29 CFR 1926.501(b)(10)).

Workers are not allowed in the area between the warning line and the unprotected edge, except during roofing work (see 29 CFR 1926.502(f)(3)). Any employee performing roofing work between the warning line and the roof edge must be protected using another form of fall protection

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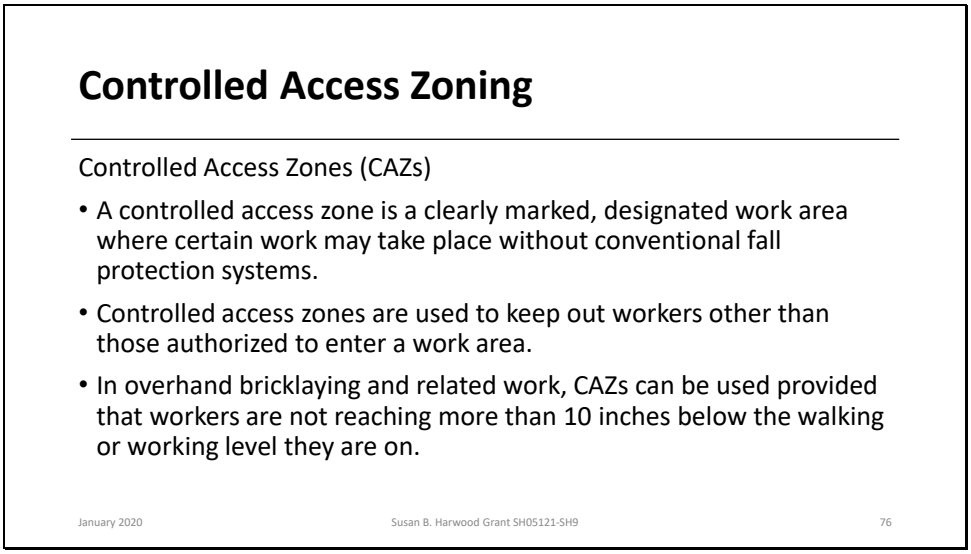

Controlled Access Zones (CAZs)

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 (see 29 CFR 1926.500(b)). Controlled access zones are used to keep out workers other than those authorized to enter a work area (see 29 CFR 1926.502(g)).

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)).

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Control Lines Used in a CAZ

- The CAZ must be erected 6 feet or less and not more than 25 feet from the unprotected or leading edge.
- When erecting precast concrete members, the control line can be up to 60 feet or half the length of the concrete.
- The control line shall be connected on each side to a guardrail system or wall.
- Each line shall be flagged or otherwise clearly marked at not more than 6-foot intervals with high-visibility material.

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).

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Controlled Decking Zones (Cdz)

- A controlled decking zone is a clearly marked work area used during steel erection.
- 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.

Discuss controlled decking zones.

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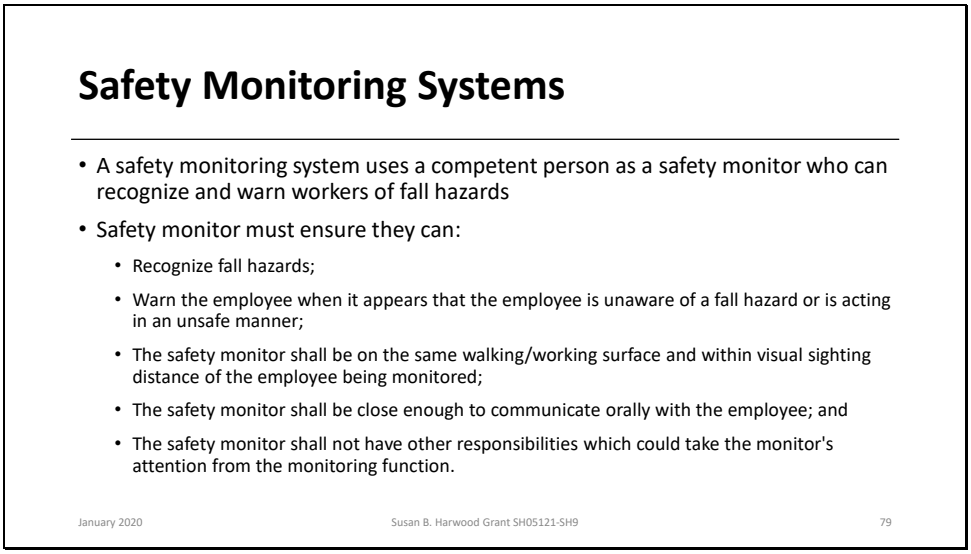

Safety Monitoring Systems

A safety monitoring system uses a competent person as a safety monitor who can recognize and warn workers of fall hazards (see 29 CFR 1926.500(b); 29 CFR 1926.502(h)(1)). 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 (see 29 CFR 1926.501(b)(10)).

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 (see 29 CFR 1926.502(h)(3)). The worker designated as the safety monitor may not perform other job tasks that could take attention away from the monitoring function (see 29 CFR 1926.502(h)(1)(v)).

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Housekeeping

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

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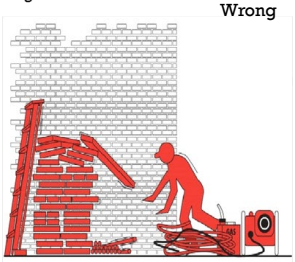

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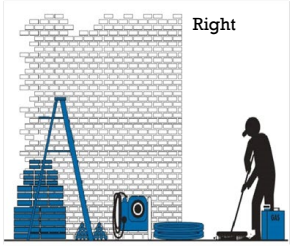

Discuss the importance of good housekeeping.

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Fall Protection Plans

The fall protection plan is:

- Used when conventional fall protection equipment is infeasible
- Prepared by a **qualified person**
- Developed specifically for the site
- May be used for leading-edge work, precast concrete work, or residential construction work
- Must be maintained

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.

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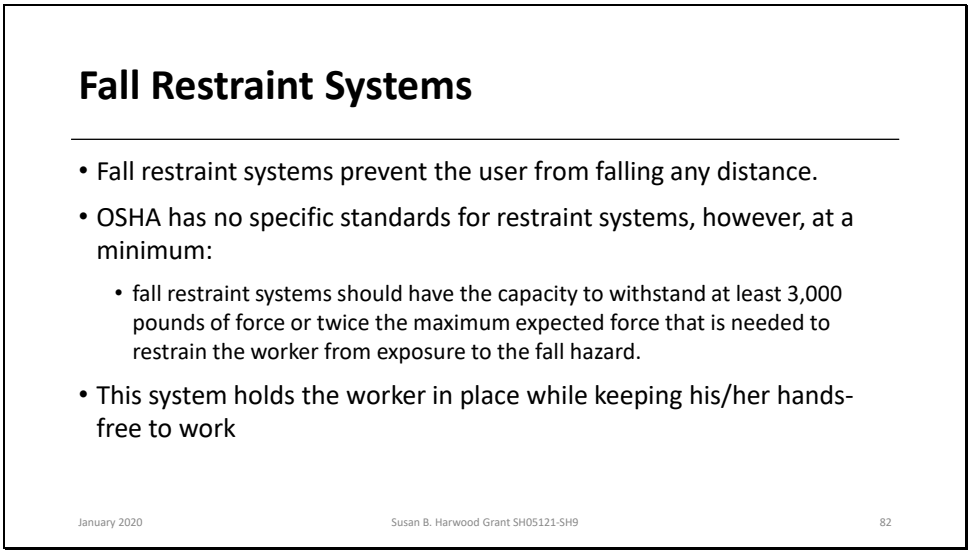

Fall Restraint Systems and Positioning Devices

Fall restraint systems prevent the user from falling any distance. To determine the force needed to restrain a worker, consideration is given to the force that would be generated by the worker walking, leaning, or sliding down the working surface. OSHA has no specific standards for restraint systems, however, at a minimum, 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.

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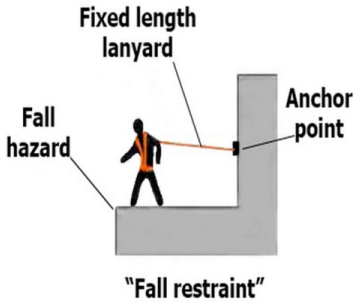
Fall Restraint Systems

- 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.



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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 are not 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.

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.

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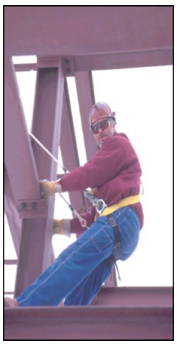
Positioning Device Systems

- Holds the worker in place while keeping hands free
- Activated when the worker leans back
- May only be used on an elevated **vertical** surface (such as wall or pole)
- Not specifically designed for fall arrest purposes
- Body belt may be used with "positioning device"
- Permit fall of up to 2 feet
- May **not** be used for bucket trucks, scissor lifts and boom-type elevating work platforms



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In §1926.500 of the construction standards for fall protection, 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 (0.6 m). 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.

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MODULE 3 NOW YOU KNOW…

- A toprail of the guardrail is 42in high and must withstand a force of at least 200 pounds.
- Toeboards shall be capable of withstanding a force of at least 50 pounds.
- A hole is anything bigger than 2 inches and color coded or marked 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
- Positioning device system are rigged to permit a fall of up to 2 feet.

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- A toprail of the guardrail is 42 in 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.
- All covers shall be color coded or they shall be marked 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 system are rigged to permit a fall of up to 2 feet.