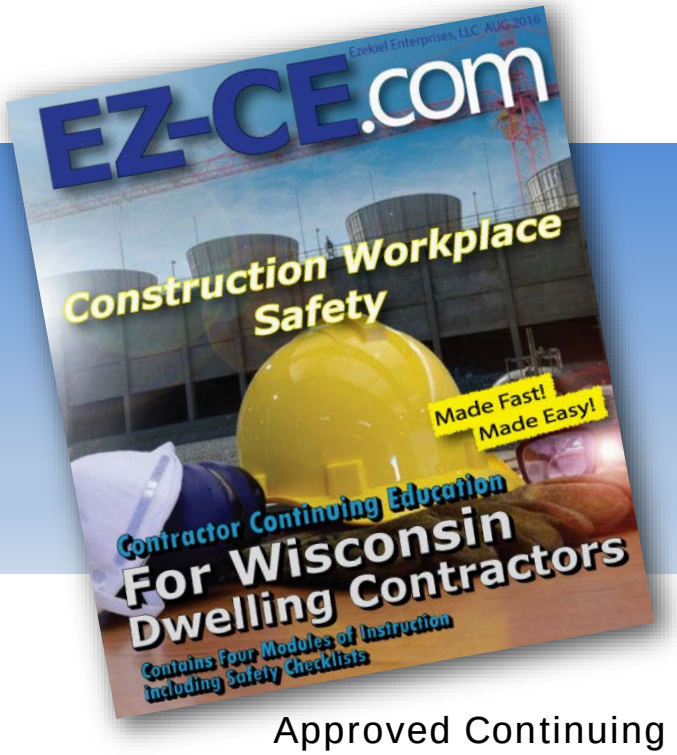

Construction Workplace Safety

Four (4) Continuing Education Hours

Wisconsin Department of Safety and Professional Services (DSPS)
Course Approval #18355

Approved Continuing Education for Wisconsin Dwelling Contractors

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Workplace Safety – Construction Fall Protection

LEARNING OBJECTIVES

Upon completion of this course, the student will be able to:

1. Identify employer's responsibilities for fall protection on construction sites
2. Review conventional fall protection systems
3. Discuss typical construction site hazards and fall protection systems required
4. Discuss fall protection training and what employers must provide
5. Understand workers' rights in regards to safety from falls

Introduction

Historically, falls are the leading cause of fatalities in construction, accounting for about one-third of all fatalities in the industry. For example, the Bureau of Labor Statistics reported that there were 291 fatal falls to a lower level in construction in 2013, out of 828 total fatalities. OSHA recognizes that incidents involving falls are generally complex events, frequently involving a variety of factors. Consequently, the standard for fall protection deals with both the human and equipment-related issues in protecting workers from fall hazards. This course is intended to help workers and employers better understand the Fall Protection in Construction standard's requirements and the reasons behind them.

This section follows OSHA guidelines, reference the following link for a full list of all OSHA Laws & Regulations.
https://www.osha.gov/law-regs.html

SUBPART M

Subpart M lays out the requirements and criteria for fall protection in construction workplaces. For example, it applies when workers are working at heights of 6 feet or more above a lower level. It also covers protection from falling objects, falls from tripping over or falling through holes, and protection when walking and working around dangerous equipment without regard to height. Subpart M provisions do not apply, however, to workers inspecting, investigating, or assessing workplace conditions prior to the actual start of work or after all construction work has been completed. The provisions of Subpart M can be found in Title 29 Code of Federal Regulations (CFR) Subpart M - Fall Protection, 29 CFR 1926.500, 29 CFR 1926.501, 29 CFR 1926.502, and 29 CFR 1926.503.

WHAT ARE EMPLOYERS' RESPONSIBILITIES TO PROVIDE FALL PROTECTION?

Initially, employers must assess the workplace to determine if walking or working surfaces have the necessary strength and structural integrity to safely support the workers. Once it is determined that the work surfaces will safely support the work activity, the employer must determine whether fall protection is required (using the requirements set forth in 29 CFR 1926.501) and, if so, select and provide workers with fall protection

systems that comply with the criteria found in 29 CFR 1926.502.

WHEN MUST EMPLOYERS PROVIDE FALL PROTECTION?

The 6-foot rule. Subpart M requires the use of fall protection when construction workers are working at heights of 6 feet or greater above a lower level. It applies at heights of less than 6 feet when working near dangerous equipment, for example, working over machinery with open drive belts, pulleys or gears or open vats of degreasing agents or acid.

WHAT CONSTRUCTION AREAS AND ACTIVITIES DOES SUBPART M COVER?

The standard identifies certain areas and activities where fall protection or falling object protection may be needed. For example, it might require fall protection for a worker who is: on a ramp, runway, or another walkway; at the edge of an excavation; in a hoist area; on a steep roof; on, at, above, or near wall openings; on a walking or working surface with holes (including skylights) or unprotected sides or edges; above dangerous equipment; above a lower level where leading edges are under construction; on the face of formwork and reinforcing steel; or otherwise on a walking or working surface 6 feet or more above a lower level. The standard may also require fall protection where a worker is: constructing a leading edge; performing overhand bricklaying and related work; or engaged in roofing work on low-slope roofs, precast concrete erection, or residential construction. In addition, the standard requires falling object protection when a worker is exposed to falling objects.

WHAT KINDS OF FALL PROTECTION SHOULD EMPLOYERS USE?

Generally, fall protection can be provided through the use of guardrail systems, safety net systems, or personal fall arrest systems. OSHA refers to these systems as conventional fall protection. Other systems and methods of fall protection may be used when performing certain activities. For example, when working on formwork, a positioning device system could be used. OSHA encourages employers to select systems that prevent falls of any kind, such as guardrails designed to keep workers from falling over the edge of a building.

EXAMPLES OF FALL PROTECTION REQUIREMENTS FOR CERTAIN CONSTRUCTION ACTIVITIES

Leading Edges – 29 CFR 1926.501(b)(2)

Each worker constructing a leading edge 6 feet or more above a lower level must be protected by guardrail systems, safety net systems, or personal fall arrest systems. 29 CFR 1926.501(b)(2)(i).

Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer must develop and implement a fall protection plan which meets the requirements of 29 CFR 1926.502(k). See the section below on Fall Protection Plans.

Workers must be protected by guardrail systems, safety net systems, or personal fall arrest systems, even if they are not engaged in leading edge work, if they are on a walking or working surface that is 6 feet or more above a level where leading edges are under construction. 29 CFR 1926.501(b)(2)(ii).

Overhand Bricklaying and Related Work – 29 CFR 1926.501(b)(9)

When workers perform overhand bricklaying and related work 6 feet or more above a lower level:

- They must be protected by guardrail systems, safety net systems, or personal fall arrest systems, or
- They must work in a controlled access zone (CAZ).

All workers reaching more than 10 inches below the level of the walking or working surface on which they are working must be protected by a guardrail system, safety net system, or personal fall arrest system.

Roofing Work on Low-Slope Roofs – 29 CFR 1926.501(b)(10)

A low-slope roof has a slope less than or equal to 4 in 12 (vertical to horizontal). When engaged in roofing work on a low-slope roof that has one or more unprotected side or edge 6 feet or more above lower levels, workers must be protected from falling by:

- Guardrail systems,
- Safety net systems,
- Personal fall arrest systems,
- A combination of conventional fall protection systems and warning line systems, or
- A warning line system and a safety monitoring system.

When engaged in roofing work on low-slope roofs 50 feet or less in width, the use of a safety monitoring system without a warning line system is permitted.

Working on Steep Roofs – 29 CFR 1926.501(b)(11)

A steep roof has a slope greater than 4 in 12 (vertical to horizontal). When working on a steep roof that has one or more unprotected side or edge 6 feet or more above lower levels, each worker must be protected by:

- Guardrail systems with toeboards,
- Safety net systems, or
- Personal fall arrest systems.

Residential Construction – 29 CFR 1926.501(b)(13)

Workers engaged in residential construction 6 feet or more above lower levels must be protected by conventional fall protection (i.e., guardrail systems, safety net systems, or personal fall arrest systems) unless another provision in 29 CFR 1926.501(b) provides for an alternative fall protection measure.

Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer must develop and implement a site-specific fall protection plan which meets the requirements of 29 CFR 1926.502(k). See the section on Fall Protection Plans, below.

Note: For purposes of determining the applicability of section 1926.501(b)(13), the term "residential construction" is interpreted as covering construction work that satisfies the following two elements:

(1) the end-use of the structure being built must be as a home, i.e., a dwelling; and

(2) the structure being built must be constructed using traditional wood frame construction materials and methods.

The limited use of structural steel in a predominantly wood-framed home, such as a steel I-beam to help support wood framing, does not disqualify a structure from being considered residential construction. For more information see OSHA's Compliance Guidance for Residential Construction, STD 03-11-002.

Other Walking or Working Surfaces – 29 CFR 1926.501(b)(15)

As a general matter, each worker on a walking or working surface 6 feet or more above a lower level must be protected from falling by a guardrail system, a safety net system, or a personal fall arrest system.

Exceptions: For exceptions to this rule that specify different requirements, see 29 CFR 1926.500(a)(2) and 29 CFR 1926.501(b)(1) through (b)(14).

CONVENTIONAL FALL PROTECTION SYSTEMS

Guardrail Systems – 29 CFR 1926.502(b)

Guardrail systems are barriers erected to prevent workers from falling to lower levels. If the employer chooses to use guardrail systems to protect workers from falls, the following provisions apply:

- Top rails, or equivalent guardrail system members, must be 42 inches plus or minus 3 inches above the walking or working level. When workers are using stilts, the top edge of the top rail, or equivalent member, must be increased an amount equal to the height of the stilts. 29 CFR 1926.502(b)(1).

- Screens, midrails, mesh, intermediate vertical members, or equivalent intermediate structural members must be installed between the top edge of the guardrail system and the walking or working surface when there are no walls or parapet walls at least 21 inches high. 29 CFR 1926.502(b)(2).

- When midrails are used, they must be installed at a height midway between the top edge of the guardrail system and the walking or working level. 29 CFR 1926.502(b)(2)(i).

- When screens and mesh are used, they must extend from the top rail to the walking or working level and along the entire opening between top rail supports. 29 CFR 1926.502(b)(2)(ii). When necessary, screens and/or mesh must be installed in a manner to prevent a worker from falling underneath.

- When intermediate members (such as balusters) are used between posts, they must not be more than 19 inches apart. 29 CFR 1926.502(b)(2)(iii).

  Other structural members (such as additional midrails and architectural panels) must be installed so that there are no openings in the guardrail system more than 19 inches wide. 29 CFR 1926.502(b)(2)(iv).

- Guardrail systems 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, at any point along the top edge. 29 CFR 1926.502(b)(3).

- Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members must 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. 29 CFR 1926.502(b)(5).

- Guardrail systems must have a surface to protect workers from punctures or lacerations and to prevent clothing from snagging. 29 CFR 1926.502(b)(6).

- The ends of top rails and midrails must not overhang terminal posts, except where an overhang poses no projection hazard. 29 CFR 1926.502(b)(7).

- Steel and plastic banding cannot be used as top rails or midrails. 29 CFR 1926.502(b)(8).

- Top rails and midrails of guardrail systems must have a nominal diameter or thickness of at least 1/4 inch to prevent cuts and lacerations. 29 CFR 1926.502(b)(9).

- If wire rope is used for top rails, it must be flagged at not more than 6-foot intervals with high-visibility material. 29 CFR 1926.502(b)(9).

- When guardrail systems are used at hoisting areas, a chain, gate, or removable guardrail section must be placed across the access opening between guardrail sections during those times when hoisting operations are not taking place. 29 CFR 1926.502(b)(10).

- When guardrail systems are used at holes, they must be set up on all unprotected sides or edges. When a hole is used for the passage of materials, it must not have more than two sides with removable guardrail sections. When the hole is not in use, it must be covered or provided with a guardrail system along all unprotected sides or edges. 29 CFR 1926.502(b)(11) & (12).

- If guardrail systems are used around holes being used as access points (such as ladderways), gates must be used. Alternatively, the point of access must be offset to prevent workers from accidentally walking straight into the hole. 29 CFR 1926.502(b)(13).

- If guardrails are used on ramps and runways, they must be erected on each unprotected side or edge. 29 CFR 1926.502(b)(14).
- Manila, plastic, or synthetic rope used for top rails or midrails must be inspected as frequently as necessary to ensure its strength and stability. 29 CFR 1926.502(b)(15).

Safety Net Systems – 29 CFR 1926.502(c)

When safety nets are used, they must be installed as close as practicable under the walking or working surface on which workers are working and never more than 30 feet below that level. 29 CFR 1926.502(c)(1). When nets are used on bridges, the potential fall area from the walking or working surface to the net must be unobstructed. 29 CFR 1926.502(c)(1). All safety nets must be installed with sufficient clearance underneath to prevent a falling body from hitting the surface or structure below the net. 29 CFR 1926.502(c)(3). If the employer chooses to use nets, the following criteria apply:

Drop-testing is required to ensure that safety nets and safety net installations are working properly. See 29 CFR 1926.502(c) (4)(i) for more details. If an employer can demonstrate that it is unreasonable to perform a drop-test, then the employer or a designated competent person must certify that the net and its installation is in compliance with the standard. See 29 CFR 1926.502(c)(4)(ii) for more details on certification and certification records.

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

- Do not use defective nets. Inspect nets at least once a week for wear, damage, or deterioration of components such as net connection points. 29 CFR 1926.502(c)(5).

- Remove materials, tools, and other items as soon as possible from the net and at least before the next work shift. 29 CFR 1926.502(c)(6).

- To work properly, a safety net must have safe openings. Mesh openings must not exceed 36 square inches, and must not be longer than 6 inches on any side. Each opening, measured center-to-center of mesh ropes or webbing, must not exceed 6 inches. 29 CFR 1926.502(c)(7).

- All mesh crossings must be secured to prevent the openings from enlarging. 29 CFR 1926.502(c)(7).

- Use safety net (or section of net) with a border rope possessing a minimum breaking strength of 5,000 pounds. 29 CFR 1926.502(c)(8).

- Do not allow one weak link to compromise a safety net. Use connections between safety net panels that are as strong as integral net components and spaced no more than 6 inches apart. 29 CFR 1926.502(c)(9).

Personal Fall Arrest Systems – 29 CFR 1926.502(d)

A personal fall arrest system is a system used to safely stop (arrest) a worker who is falling from a working level. It consists of an anchorage, connectors, and a body harness. It also may include a lanyard, deceleration device, lifeline, or suitable combinations of these. Under Subpart M,

body belts (safety belts) are prohibited for use as part of a personal fall arrest system.* When employers choose to use a personal fall arrest system as a means of worker fall protection they must:

- Limit the maximum arresting force on a worker to 1,800 pounds when used with a body harness. 29 CFR 1926.502(d)(16)(ii).
- Be rigged so that a worker can neither free fall more than 6 feet nor contact any lower level. 29 CFR 926.502(d)(16)(iii).
- Bring a worker to a complete stop and limit the maximum deceleration distance a worker travels to 3.5 feet. 29 CFR 1926.502(d)(16)(iv).
- Have sufficient strength to withstand twice the potential impact energy of a worker free falling a distance of 6 feet or the free fall distance permitted by the system, whichever is less. 29 CFR 1926.502(d)(16)(v).
- Be inspected prior to each use for wear, damage, and other deterioration. Defective components must be removed from service. 29 CFR 1926.502(d)(21).

Note: Limited use of body belts (safety belts) can still be used as part of a positioning device system or fall restraint system See more information under Positioning Device Systems and Fall Restraint Systems, below.

Personal Fall Arrest System Components

Snaphooks

- Snaphooks must be the locking type and designed and used to prevent disengagement from any component part of the personal fall arrest system. 29 CFR 1926.502(d)(5).
- Locking type snaphooks may also be used when designed for the following connections:
  - directly to webbing, rope, or wire rope;
  - to each other;
  - to a Dee-ring to which another snaphook or other connector is attached;
  - to a horizontal lifeline; or
  - to any object which is incompatibly shaped or dimensioned in relation to the snaphook, such that unintentional disengagement could occur by the connected object being able to depress the snaphook keeper and release itself. 29 CFR 1926.502(d)(6).

Horizontal Lifelines

- On suspended scaffolds or similar work platforms with horizontal lifelines that may become vertical lifelines, the devices used to connect to a horizontal lifeline must be capable of locking in both directions on the lifeline. 29 CFR 1926.502(d)(7).
- Horizontal lifelines must be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system that maintains a safety factor of at least two. 29 CFR 1926.502(d)(8).

Vertical Lifelines and Lanyards

Vertical lifelines and lanyards must have a minimum breaking strength of 5,000 pounds. 29 CFR 1926.502(d)(9).

- Lifelines must be protected against being cut or abraded. 29 CFR 1926.502(d)(11).

Self-retracting Lifelines and Lanyards

- Self-retracting lifelines and lanyards that automatically limit free fall distance to 2 feet or less must be capable of sustaining a minimum tensile load of 3,000 pounds applied to the device with the lifeline or lanyard in the fully extended position. 29 CFR 1926.502(d)(12).
- Self-retracting lifelines and lanyards which do not limit free fall distance to 2 feet or less, ripstitch lanyards, and tearing and deforming lanyards must be capable of sustaining a minimum tensile load of 5,000 pounds applied

to the device with the lifeline or lanyard in the fully extended position. 29 CFR 1926.502(d)(13).

Ropes and Straps

- Ropes and straps (webbing) used in lanyards, lifelines, and strength components of body belts and body harnesses must be made of synthetic fibers. 29 CFR 1926.502(d)(14).

Anchorages

- Anchorages used to attach personal fall arrest systems must be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system which maintains a safety factor of at least two. Alternatively, the anchorages must be independent of any anchorage being used to support or suspend platforms and must be capable of supporting at least 5,000 pounds per worker attached or be capable of supporting at least twice the expected impact load. 29 CFR 1926.502(d)(15).

TYPICAL CONSTRUCTION SITE HAZARDS THAT REQUIRE FALL PROTECTION

A construction environment poses many hazards requiring protection. Below are some fall hazards that cannot be overlooked.

Hoist Areas – 29 CFR 1926.501(b)(3)

Each worker in a hoist area must be protected from falling 6 feet or more by guardrail systems or personal fall arrest systems. There may be times when the guardrail systems (or chain, gate, or guardrail) must be removed in whole or part to facilitate hoisting operations. For example, during the landing of materials, a worker may need to lean through the access opening or out over the edge of the access opening to receive or guide equipment and materials. At such times a personal fall arrest system must be used to protect the worker from falling through the unprotected opening.

Holes – 29 CFR 1926.501(b)(4)

- Each worker on walking or working surfaces must be protected from falling through holes (including skylights) that are more than 6 feet above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes. 29 CFR 1926.501(b)(4)(i).

- Each worker on a walking or working surface must be protected from tripping in or stepping into or through holes (including skylights) by covers. 29 CFR 1926.501(b)(4)(ii).

Ramps, Runways, and Other Walkways – 29 CFR 1926.501(b)(6)

Each worker on a ramp, runway, or other walkway must be protected by guardrail systems against falling 6 feet or more.

Excavations – 29 CFR 1926.501(b)(7)

- Each worker at the edge of an excavation 6 feet or more deep must be protected from falling by guardrail systems, fences, or barricades when the excavation cannot be readily seen because of plant growth or other visual barrier. 29 CFR 1926.501(b)(7)(i).

- Each worker at the edge of a well, pit, shaft, and similar excavation 6 feet or more deep must be protected from falling by guardrail systems, fences, or barricades, or covers. 29 CFR 1926.502(b)(7)(ii).

Dangerous Equipment – 29 CFR 1926.501(b)(8)

- When working 6 feet or more above dangerous equipment, each worker must be protected by guardrail systems, safety net systems, or personal fall arrest systems. 29 CFR 1926.502(b)(8)(ii).

- When working less than 6 feet above dangerous equipment, each worker must be protected from falling into or onto the dangerous equipment by

a guardrail system or equipment guards. 29 CFR 1926.502(b)(8)(i).

Wall Openings – 29 CFR 1926.501(b)(14)

Each worker working on, at, above, or near wall openings (including those with chutes attached), where the outside bottom edge of the wall opening is 6 feet or more above lower levels and the inside bottom edge of the wall opening is less than 39 inches above the walking or working surface, must be protected with a guardrail system, a safety net system, or a personal fall arrest system.

PROTECTION FROM FALLING OBJECTS

Falling objects can also pose a hazard to workers. Falling object protection must comply with the following provisions:

Guardrails – 29 CFR 1926.502(j)(5)

When guardrail systems are used to prevent materials from falling from one level to another, any openings must be small enough to prevent passage of falling objects.

Overhand Bricklaying and Related Work – 29 CFR 1926.502(j)(6)

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

Roofing Work – 29 CFR 1926.502(j)(7)

During roofing work, materials and equipment must not be stored within 6 feet of a roof edge unless guardrail systems are erected at the edge. Any materials piled, grouped, or stacked near a roof edge must be stable and self-supporting.

Toeboards – 29 CFR 1926.502(j)(1) through (4)

When toeboards are used as protection from falling objects, they must be erected along the edges of the overhead walking or working surface for a distance sufficient to protect workers working below. 29 CFR 1926.502(j)(1). Other criteria include:

- Toeboards must 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. 29 CFR 1926.502(j)(2).
- Toeboards must be at least 3.5 inches tall from their top edge to the level of the walking or working surface, must have no more than 0.25 inch clearance above the walking or working surface, and must be solid or have openings no larger than one inch in its greatest dimension. 29 CFR 1926.502(j)(3).
- Where tools, equipment, or materials are piled higher than the top edge of a toeboard, paneling or screening must be erected from the walking or working surface or toeboard to the top of a guardrail system's top rail or midrail, for a distance sufficient to protect workers below. 29 CFR 1926.502(j)(4).

Canopies – 29 CFR 1926.502(j)(8)

When used as protection from falling objects, canopies must be strong enough to prevent collapse and to prevent penetration by any objects that may fall onto them.

FALL PROTECTION TRAINING

Requirements – 29 CFR 1926.503

Employers must provide a fall protection training program to workers who might be exposed to fall hazards. Training must include how to recognize fall hazards and how to minimize them. 29 CFR 1926.503(a)(1).

The employer must assure that each worker has been trained as necessary, by a competent person who is qualified in the following areas:

- The nature of fall hazards in the work area. 29 CFR 1926.503(a)(2)(i).
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used. 29 CFR 1926.503(a)(2)(ii).
- The use and operation of controlled access zones; guardrail, personal fall arrest, safety net, warning line, and safety monitoring systems; and other protection to be used. 29 CFR 1926.503(a)(2)(iii).
- The role of each worker in the safety monitoring system when the system is used. 29 CFR 1926.503(a)(2)(iv).
- The limitations on the use of mechanical equipment during the performance of roofing work on low-slope roofs. 29 CFR 1926.503(a)(2)(v).
- The correct procedures for equipment and materials handling and storage and the erection of overhead protection. 29 CFR 1926.503(a)(2)(vi).
- The role of workers in fall protection plans. 29 CFR 1926.503(a)(2)(vii).
- OSHA's fall protection requirements, published as Subpart M. 29 CFR 1926.503(a)(2)(viii).

Verification of Training

Employers must verify worker training by preparing a written certification record. The record must contain the name or other identity of the worker trained, the dates of the training, and the signature of either the person who conducted the training or the employer. 29 CFR 1926.503(b)(1).

When an employer has reason to believe that an affected worker does not recognize existing fall hazards at some point after the initial training, the employer is required to provide retraining for that worker. For example, workers must be retrained when:

- Changes in the workplace render previous training obsolete. 29 CFR 1926.503(c)(1).
- Fall protection equipment or systems have changed. 29 CFR 1926.503(c)(2).
- Inadequacies in workers' knowledge or use of fall protection systems or equipment indicate that they have not adequately understood or retained previous training. 29 CFR 1926.503(c)(3).

WORKERS' RIGHTS

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

REFERENCES

Fall Protection in Construction:
https://www.osha.gov/Publications/OSHA3146.pdf

OSHA laws and Regulations:
https://www.osha.gov/law-regs.html

OSHA Training:
https://www.osha.gov/dte/index.html

OSHA Regulations (Standards – 29 CFR) Construction:

https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=Construction

OSHA Publications:
https://www.osha.gov/pls/publications/publication.html

Workplace Safety – Silica Exposure in Construction

LEARNING OBJECTIVES

Upon completion of this module, the student will be able to:

1. Describe the hazards associated with silica and the typical construction site materials which may present this hazard
2. Review common construction site operations where this hazard is most prevalent.
3. Review mitigation techniques to reduce this hazard while performing and using standard construction site tools and materials
4. Identify the proper respirator to use when performing construction site operations
5. Discuss best work practices to minimize inhalation risks on sites with potential silica exposure

Introduction

This section addresses the control of exposures to respirable dust containing crystalline silica, which is known to cause silicosis, a serious lung disease, as well as increase the risk of lung cancer and other systemic diseases. The following provides information on the effectiveness of various engineering control approaches for several kinds of construction operations and equipment, and contains recommendations for work practices and respiratory protection, as appropriate.

BACKGROUND

Quartz is the most common form of crystalline silica. In fact, it is the second most common surface material accounting for almost 12% by volume of the earth's crust. Quartz is present in many materials in the construction industry, such as brick and mortar, concrete, slate, dimensional stone (granite, sandstone), stone aggregate, tile, and sand used for blasting. Other construction materials that contain crystalline silica are asphalt filler, roofing granules, plastic composites, soils, and to a lesser extent, some wallboard joint compounds, paint, plaster, caulking and putty. Cristobalite, a less common form of crystalline silica, is formed at high temperatures (>1,470°C) in nature and by industrial processes. The ceramic and brick lining of boilers and vessels, some ceramic tiles, and volcanic ash contain cristobalite.

Of course, potential silica exposure levels will depend on the concentration of silica in materials at construction sites, as well as factors in the work environment (such as enclosed, semi-enclosed, or open spaces and/or multiple operations generating silica dust) as well as environmental conditions (such as wind direction and speed). Therefore, employers are encouraged to conduct periodic exposure monitoring to confirm that engineering and work practice controls are effective and that appropriate respiratory protection is being used where necessary. Controls continue to evolve and it is encouraged that equipment suppliers and contractors to work with industrial hygienists to evaluate new designs and products to obtain objective information that can be used to evaluate performance and support informed decisions on use.

This section is divided into nine sections that cover different construction operations. Eight are for specific equipment or operations: Stationary Masonry Saws, Handheld Masonry Saws, Hand-Operated Grinders, Tuckpointing/Mortar Removal, Jackhammers, Rotary Hammers and Similar Tools, Vehicle-Mounted Rock Drilling Rigs, and Drywall Finishing.

MASONRY SAWS: STATIONARY & HANDHELD

Exposure to fine particles of silica has been shown to cause silicosis, a serious and sometimes fatal lung disease. Construction employees who inhale fine particles of silica may be at risk of developing this disease. Employees produce dusts containing silica when they cut, grind, crush, or drill construction materials such as concrete, masonry, tile and rock. The small particles easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

Studies show that using a stationary masonry saw to cut bricks, concrete blocks and similar materials can result in hazardous levels of airborne silica if measures are not taken to reduce dust emissions. Stationary saws should always be used with dust control measures. At worksites without dust controls for these tools, studies have found that employee silica exposures can be as high as 20 times the Occupational Safety and Health Administration's (OSHA) benchmark

SILICA DUST CONTROL MEASURES

Wet Cutting

Most stationary saws come equipped with a water basin that typically holds several gallons of water and a pump for recycling water for wet cutting. If a saw's water supply system is not currently operating, the manufacturer may be able to supply the necessary accessories to reactivate wet cutting capability. Most suppliers stock these accessories since water cooling prolongs the life of the saw blade and tool.

Wet cutting is the most effective method for controlling silica dust generated during sawing because it controls the exposure at its source. Dust that is wet is less able to become or remain airborne.

Maintenance.

To minimize dust emissions from saws equipped for wet cutting, keep pumps, hoses and nozzles in excellent operating condition. Regular saw maintenance reduces silica exposures and ensures optimal operation of the equipment. Saws and dust control devices should be on a routine maintenance schedule.

Vacuum Dust Collection Systems

When wet methods cannot be implemented, one alternative is the use of vacuum dust collection (VDC) systems. Stationary masonry saws with VDC systems are commercially available and have the ability to capture a substantial amount of dust. With these systems, a vacuum pulls dust from the cutting point through special fittings connected directly to the saw (fixed-blade saws) or, alternatively, through a dust collection device connected to the back of the saw (plunge-cut saws). A dust collector (exterior hood) mounted to the back of a saw requires a high exhaust airflow to ensure good dust capture between the saw blade and dust collector.

VDC systems can be purchased as a kit. These kits should include a dust collector (exterior hood), vacuum, vacuum hose, and filter(s). The components of a VDC system are discussed below.

- Dust collector (exterior hood): Be sure to use the appropriate sized dust collector for the wheel and if it is a retrofit on the saw, be sure to follow the manufacturer's instructions when installing the device.

- Vacuum: Choose a vacuum with the appropriate power and capacity for your job. Obtaining a flow rate on a VDC system of 80 CFM or better

will give the best results while performing mortar removal.

- Vacuum hose: A flow rate of 80 CFM is best maintained with a 1½- to 2-inch diameter hose. If the diameter is larger, the airflow velocity will be reduced. If the diameter is smaller, airflow resistance will be higher. Airflow resistance also increases with hose length; excessively long hoses should be avoided.

- Filters: Double filtration is important. The use of a high-efficiency particulate air (HEPA) filter is critical to prevent the escape of respirable silica dust from the vacuum exhaust. HEPA filters are at least 99.97 percent efficient in removing fine dust particles from the air. A prefilter or cyclonic separator in addition to a HEPA filter will improve vacuum efficiency and extend the service life of the more costly HEPA filter. A cyclonic separator removes large particles that are capable of overloading or clogging the filter.

- Systematic cleaning: Choose a vacuum equipped with a back-pulse filter cleaning cycle. Such auto-cleaning mechanisms will reduce the time required for vacuum maintenance and improve the overall efficiency of the dust collection system. If the vacuum does not have an auto-cleaning mechanism, the employee can periodically turn the vacuum cleaner on and off. This allows the bag to collapse and causes the prefilter cake to dislodge from the filter.

- Monitoring VDC efficiency: Purchasing a dust collection system equipped with a static pressure gauge allows the employee to monitor the system's efficiency. Systems lacking a static pressure gauge can be monitored visually. If a dust plume increases and becomes more visible where the dust collector meets the working surface, the system is not working efficiently.

Ventilation Booths

A booth (with fan) erected around a saw can help reduce dust, but may require some experimentation to provide adequate effectiveness. The following are tips for design an effective booth.

- Minimize the size of the operator opening to reduce the chance of dust escaping into the operator's breathing area.

- Use a fan large enough to provide an average of 250 feet per minute air velocity across the face of the operator opening.

- Do not let the saw blade protrude beyond the open face of the booth.

- Build a trapdoor into the lower back of the booth to access the interior for cleaning and to remove debris.

- Always position the booth so that the exhaust fan does not blow dusty air on other employees. When possible, have the booth exhaust downwind.

Fans

Fans are not effective dust control devices when used as the sole control method and should not be used as the primary method for managing dust. Fans can, however, be useful as a supplement to other control methods. Use fans in enclosed areas, such as bathrooms, where dust would build up due to poor air circulation.

For the best effect, set an exhaust fan (the bigger, the better) in an open window or external doorway. Position the saw nearby, so that the fan captures dust and blows it outside. Avoid positioning employees between the saw and the fan. Also, avoid positioning employees near the exhausted air. An exhaust fan works best if a second window or door across the room is open to allow fresh air to enter.

Note: The use of compressed air to clean surfaces or clothing is strongly discouraged. Using compressed air to clean work surfaces or clothing can significantly increase employee exposure, especially in enclosed and semi-enclosed

spaces. Cleaning should be performed with a HEPA-filtered vacuum or by wet methods.

GRINDING & TUCKPOINTING

Employees produce dusts containing silica when they grind on concrete and similar materials. The grinders' abrasive action generates fine particles that easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

In fact, on average, grinder operators' silica exposures (along with those of tuckpointers) are among the highest in the construction industry.

SILICA DUST CONTROL MEASURES

Vacuum Dust Collection Systems

Vacuum dust collection (VDC) systems for grinders include a shroud, which surrounds the grinding wheel, hose, filters and a vacuum to pull air through the shroud. Many manufacturers offer grinders with dust collection options. Employers may also purchase equipment to retrofit grinders for vacuum dust collection. The effectiveness of vacuum systems depends on several factors, including the user's technique, the surfaces being finished, and the efficiency of the dust collection system.

Wet Grinding

Water provides excellent dust control during tasks involving abrasive action on concrete. When applied at the point where dust is generated, water wets the dust particles before they can become airborne. Water-fed equipment is regularly used to control dust during granite and concrete grinding and polishing operations, as well as during concrete and masonry cutting with abrasive wheels. These tools include a nozzle or spout that provides a stream of water to the grinding wheel. For example, some equipment provides water through a hole in a hollow shaft or a nozzle at the edge of the wheel.

Adjustments in Work Methods

Employee Positioning

Where possible, exposures can be reduced if employees work at a greater distance from the grinding point. These reductions have been demonstrated for employees grinding on ceilings and for employees sanding drywall. Dust falls on employees who stand directly below the grinding point. If the grinder is attached to an adequately supported pole, the employee can manipulate the grinder at a distance from one side where the dust is less concentrated. While this method does not eliminate exposure, it can help reduce the amount of dust in the employee's breathing area.

Grinding Wheel Size

A study comparing construction employees' respirable silica exposure at nine construction sites found that short-term exposure levels were about 30 percent higher for employees operating grinders with 7-inch wheels than for operators grinding with 4.5-inch wheels. Additionally, diamond wheels used for rougher, more aggressive grinding were associated with exposure levels approximately 60 percent higher than those associated with abrasive wheels used for fine finishing. Therefore, whenever possible, use a smaller rather than a larger wheel, and use the least aggressive tool that will do the job.

Construction Work Methods

Where practical, employers can reduce employees' silica exposures by utilizing construction methods and techniques that minimize the amount of grinding required. Examples include taking steps to minimize pouring/casting flaws and defects by ensuring tighter fitting forms, improved finishing, grinding on pre-cast panels outdoors before installation inside, or using factory installed chase and grooves on pre-cast structural. Silica exposures may also be reduced if grinding is done while the concrete is still "green". Additionally, for a given amount of material removed from a surface, less airborne dust will be generated if some of the material can be removed as larger chips instead of finely ground particles. An employee might use a

hammer and chisel or power chipping equipment to remove most of the mass before using a grinder to smooth the surface.

JACKHAMMERS

Workers produce dusts containing silica when they use breaker hammers (commonly known as jackhammers) to chip and break rocks or concrete. The hammer's crushing action generates small particles that easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

SILICA DUST CONTROL MEASURES

Wet Methods

Wet methods reduce dust by wetting the material at the impact point, before the dust gets into the air. Wet particles are heavier and more likely to stick to each other than dry particles and tend to settle more quickly. Thus, wet methods decrease the amount of particulate matter suspended in the air. This form of dust suppression is effective for both respirable and visible dust.

The ideal wet method of dust control uses the minimum amount of water to get the maximum result. Spray directed at the point of impact is optimal. The spray must not be too fine otherwise the air motion around the jackhammer will not allow the spray to contact dust at the impact point. For example, employees operating 90-pound jackhammers reduced their silica exposure between 50 and 98 percent using just 1/8 gallon of water per minute as a spray.

Water for dust suppression can be applied manually, or using a semi-automated water-feed device.

Manual spraying

In the simplest method for suppressing dust, a dedicated helper directs a constant spray of water at the impact point, while another employee operates the jackhammer. The helper can use a hose with a garden-style nozzle to maintain a steady and carefully directed spray at the impact point where material is broken and crushed.

An experienced helper will be able to adjust the water flow to achieve the maximum dust suppression using the minimum amount of water, thus reducing water run-off.

Periodically picking up a hose and spraying the general area is not effective. Simply pre-wetting the concrete or asphalt prior to breaking the surface is also ineffective. Because the jackhammer continues to break through silica-containing material, dust is constantly produced. To be effective, spray application must be continuous and directed at the point of impact.

Water Spray System

This alternative uses the same principle as manual spraying, but eliminates the need for a helper to hold the hose.

Jackhammers retrofitted with a spray nozzle aimed at the tip of the tool offer a dramatic decrease in silica exposure. Although water-fed jackhammers are not commercially available, it is neither expensive nor difficult to retrofit equipment and parts are available at well-stocked hardware stores

ROTARY HAMMERS AND SIMILARTOOLS

Using rotary hammers or similar tools to drill small-diameter holes in concrete, bricks, masonry blocks, tiles and similar materials can expose employees to hazardous levels of airborne silica if measures are not taken to suppress dust emissions.

SILICA DUST CONTROL MEASURES

Vacuum Dust Collection Systems

Vacuum dust collection (VDC) systems are commercially available for handheld drills, usually as add-on systems. The systems enclose the drill bit in a suction ring (dust entrance), which

includes a port for attaching a vacuum to collect dust and concrete particles generated during drilling.

Dust Barriers

An employee who drills only an occasional small hole in the course of a day may have relatively low silica exposure. It is a good idea to minimize exposure to even small amounts of silica dust, so you might want to experiment with techniques for capturing dust from a single small hole initially developed in the asbestos abatement industry.

One simple dust control method involves inserting the drill bit through a barrier, which is then pressed against the working surface during drilling. The dust exiting the hole collects against the barrier. If the barrier is damp, it forms a better seal against the working surface and also moistens the dust, thus capturing more dust and reducing the amount that can escape when the employee For example, employees sometimes drill through shaving cream in an upside-down waxed paper cup or through a damp sponge to minimize exposure to asbestos. These materials compress and are held in place by the pressure of the advancing drill. Assuming the barrier material can make a good connection with the surface, this method is appropriate for most materials that an employee might drill.

Tips for Devising a Dust Barrier for Occasional Drilling.

For optimal results, the following measures are recommended:

- Insert the drill bit through the barrier until the tip is just visible, and then set the tip against the working surface in the correct position.
- Ensure that there are no gaps between the working surface and the barrier through which small particles can escape and become airborne.
- Withdraw the drill bit by pulling it through the barrier, so that the barrier collects any debris drawn out with the bit.
- Dispose of dust and debris after completing each hole. Handle the barrier carefully to minimize dust release.
- Add a moist material to the barrier to wet dust and minimize release during disposal.
- When using a cup, use waxed paper, which will compress under pressure, rather than Styrofoam, which will crack.
- Do not allow the barrier to become overloaded. For deeper holes, periodically check under the barrier; it may be necessary to clean or empty it before the hole is complete.

Wet Methods

Wet methods are generally not appropriate for use with electric rotary hammers unless the tools are designed for use in damp environments.

Pneumatic drills, however, can be used for wet drilling, and some come equipped with a water feed capability. While designed primarily for use in explosive atmospheres, water-fed pneumatic drills can also be used to control silica exposures.

Wet methods are usually the most effective way to control silica dust generated during construction activities because wet dust is less able to become or remain airborne. Although few specific data are available regarding wet methods for drilling small holes, studies have shown that drilling with water-fed bits or water spray at the bit-rock interface can substantially reduce respirable dust generated by rock drilling rigs

VEHICLE-MOUNTED ROCK DRILLING RIGS

Workers produce dusts containing silica when they use rock-drilling rigs mounted on trucks, crawlers or other vehicles to drill into rock, concrete, or soil. Studies have shown that drilling

into rock, concrete, or soil may produce hazardous levels of respirable silica if measures are not taken to limit and control dust emissions.

SILICA DUST CONTROL MEASURES

Dust Collection Systems

Various types of dust collection systems are available for earth drills. Commonly used equipment incorporates a movable suction duct attached to a shroud (a flexible rubber skirt) that encloses the drill hole opening and captures the cuttings coming through the hole. Drilling equipment that does not include these controls can be retrofitted by the manufacturer or a mechanical shop.

Dusty air pulled from the shroud enclosure usually passes through a flexible duct leading to a primary dust separator and a secondary filter system. The dust separator often includes a self-cleaning "back-pulse" feature that discharges the collected particles to the ground. Some secondary filter systems are also self-cleaning. Finally, the exhaust air is discharged to the atmosphere.

Wet Methods

The proper use of wet methods requires a skilled operator. In wet drilling, too much water can create mud slurry at the bottom of the hole that can entrap the bit, coupling and steel extensions. Too little water will not effectively control dust emissions. Studies indicate that the optimal water flow rate is best achieved by slowly increasing the water to the point where visible dust emissions are eliminated.

While water injection methods work well for percussion, drag and button bits, special consideration is required to protect bits with rollers (tri-cone bits) from excess water on moving parts.

Operator Isolation

Drill operators using rigs with enclosed cabs can reduce their potential silica exposure by spending as much time as possible inside the vehicle cab while drilling is in progress. To be effective, the cab must be well sealed and ventilated. Door jams, window grooves, power line entries and other joints should be tightly sealed. Provide a slight positive pressure, using filtered air, to prevent dust from leaking into the cab. For the best dust control, use a high-efficiency particulate air (HEPA) filter. Some equipment permits the operation of the drill from inside the cab.

An exposure survey found that if operators spend time inside a fully enclosed cab and use wet drilling together with a dust collection system, dust exposures can be reduced up to 76 percent when compared to wet drilling alone. While the use of enclosed cabs substantially reduces silica exposures, operators might be unwilling to keep windows and doors closed if the cab is not air conditioned. Equipment might be upgraded by installing aftermarket ventilation and air conditioning systems. Even in a sealed cab, dust already inside the cab can become airborne. Clean cabs daily to remove dust tracked in on boots or settled on surfaces.

DRYWALL FINISHING

Even when dust does not contain silica, employees performing dusty jobs may be at risk. Excessive exposure to airborne dust can contribute to tissue injury in the eyes, ears and respiratory passages.

When sanding drywall joint compound, employees generate a substantial amount of airborne dust. The smallest dust particles – the respirable particles – are hazardous because they are deposited deep in the lungs. Dust that contains silica presents a particularly dangerous hazard, but exposure to high levels of dust, whether or not it contains silica, can also be harmful to health. To avoid potentially hazardous exposures, employers should implement effective dust control measures during all drywall finishing activities.

The primary method for avoiding silica exposure, and thereby eliminating the risk of developing silicosis, is to use only silica-free joint compounds.

Drywall finishers can also reduce their dust exposure by using vacuum dust collection equipment or wet sanding methods.

SILICA DUST CONTROL MEASURES

Silica-Free Joint Compounds

Many manufacturers offer joint compounds that contain little or no silica. In a study of six brands of joint compound purchased at retail stores, no crystalline silica was detected in three brands. The silica present in a sample of one of the six products, however, was substantially different from the percentage listed on the material safety data sheet (MSDS) for that product. Nonetheless, OSHA recommends that employers rely on manufacturers' information and use proper methods to minimize employees' dust exposures, rather than testing joint compounds themselves.

Vacuum Dust Collection Systems

Vacuum dust collection (VDC) systems for drywall sanding equipment are commercially available, and studies show that they significantly reduce total dust concentrations. Vacuum dust collection systems typically consist of a sanding screen and a head, with a hose port to connect a portable wet or dry vacuum. Vacuum sanders can be handheld or pole-mounted.

Wet Sponge Method

Wet methods are often the most effective means of controlling dust because particles never have a chance to become airborne. Drywall compound manufacturers often recommend using wet finishing methods for dust control.

The wet sanding method for drywall finishing uses a sponge to wet the drywall joint compound and remove residues. For wet sanding, saturate a sponge with clean lukewarm water and wring it out to prevent dripping. Then gently rub the high spots using as few strokes as possible to avoid grooving the joints. The sponge should be cleaned frequently.

In addition to reducing employee exposures, wet finishing methods offer other advantages. For example, wet methods often require less cleanup, the wallboard face is not scuffed during finishing, and joints are easier to conceal with paint than joints that are dry sanded. Wet finishing can be more complicated on poorly finished joints because employees may find it difficult to remove large amounts of joint compound with this method. Therefore, employees should apply joint compound smoothly so that little finishing is required.

Some contractors are concerned about the increased drying time associated with wet methods. All wet-sanded areas must dry thoroughly before applying additional coats of joint compound or decorating. Some employees, however, already use heat guns or space heaters to shorten joint compound drying times; these methods allow painting to begin sooner, even after wet sanding. Further, the time spent drying the joint compound might be offset by the time it would otherwise take to remove dust particles from the walls before painting.

TIPS FOR USING DRYWALL SPONGES

- Use quality application techniques to minimize excess joint compound on the surface.
- Use as few sanding strokes as possible to avoid grooving the surface.
- Use drying aids to shorten drying time.
- Make sure that sponges and water buckets are thoroughly cleaned after each use to prevent dust from drying on the equipment and becoming airborne.
- Consult manufacturers' recommendations for wet sanding drywall compounds.

RESPIRATORY PROTECTION

Overall, effective wet methods are invaluable in keeping silica levels below hazardous levels.

However, in situations where wet methods may not be appropriate or feasible, and VDC systems are used as an alternative control option. It is necessary to supplement the VDC system with the worker wearing a properly fitted, NIOSH-approved half-face-piece or disposable respirator equipped with an N-, R- or P- 95 filter to ensure exposure is below hazardous levels.

In situations, where neither method (Wet, VDC) can be incorporated, it is necessary for the worker to wear a full-face-piece respirator equipped with an N-, R- or P-95 filter to ensure exposure is below hazardous levels.

For more information on how to determine proper respiratory protection, visit OSHA's Web site at www.osha.gov.

Other employees in close proximity to the work operations where silica dust is generated may also need respiratory protection if effective controls are not implemented. The level of respiratory protection is dependent on the employee's silica exposure, which varies depending on factors in the work environment (such as enclosed, semi-enclosed, or open spaces and/or multiple operations generating silica dust), environmental conditions (such as wind direction and speed), and the percentage of silica found in the material.

WORK PRACTICES

Common sense work practices can help employees limit their exposure to silica. Examples include:

- Clean up spills and waste before dust can spread.
- Wear a rubber apron to keep wet dust off clothing. When it dries, the dust can become airborne.
- Whenever possible, work upwind of any dust sources. This can be as simple as working from the other side of the pile when shoveling debris.
- Keep roadways damp at sites where the surface includes high silica aggregate or crushed concrete.
- Wet down silica-containing debris and rock spoil piles prior to removal or disturbance. Encourage employees to watch for dust sources containing silica and make adjustments or use dust control methods to reduce their silica exposure.

Dumping or Pouring Materials

The farther objects fall when dropped, the more dust they will generate on impact. When dumping or pouring materials (for example, debris into a dumpster or raw materials into a mixer), minimize drop distances by releasing materials close to their destination level. Support the bag, bin, or barrow just above the top of the pile and slowly add materials onto the pile. When a long drop is unavoidable, use enclosed disposal chutes or slides.

- Use wheelbarrow ramps of appropriate height (not too tall for a small dump pile).
- Moisten the dumpster contents, floors and walls prior to adding any debris to reduce dust released upon impact.
- Spray the debris stream with water mist to help suppress dust.

Sweeping

- Take steps to limit the use of dry sweeping. Reduce the quantity of debris and the distance and frequency of sweeping. Use a vacuum or wet mop, or moisten the material and scrape it into position.
- Collect and transport debris by bucket or wheelbarrow from smaller local piles rather than pushing it for longer distances to a central pile.
- Avoid dry sweeping debris with sweeping compounds that contain quartz sand (crystalline silica) as the grit.

Removing Debris from Slots or Uneven Surfaces

- Use a vacuum instead of a blower. Use vacuum hose attachments sized for the situation. For example, remove tailings from handheld drill holes using a HEPA-filtered vacuum.
- Flush cracks with water instead of using compressed air.

Vacuums

- Use vacuums with self-cleaning features (back-pulse). Make sure that employees are fully trained in vacuum operation.
- Handle vacuum bags carefully and have a disposal receptacle nearby.
- Avoid overfilling vacuum canisters or bags. The extra weight makes bags difficult to handle and subject to tearing.
- Avoid shaking or jarring the vacuum. Follow the manufacturer's instructions for recommended handling.
- Avoid depositing or storing collected debris where it will be disturbed or run over and become a source of dust exposure for another employee.

REFERENCES

Controlling Silica Exposure in Construction: https://www.osha.gov/Publications/3362silica-exposures.pdf

OSHA laws and Regulations: https://www.osha.gov/law-regs.html

OSHA Regulations (Standards – 29 CFR) Construction: https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=Construction

OSHA Publications: https://www.osha.gov/pls/publications/publication.html

Workplace Safety – Nail Gun Safety

LEARNING OBJECTIVES

Upon completion of this module, the student will be able to:

1. Review common nail gun injuries and what can be done to mitigate the hazards
2. Identify the various trigger mechanisms and their controls
3. Discuss why nail gun injuries happen including the seven major risk factors associated
4. Understand the six steps to nail gun safety used to mitigate nail gun risks
5. Recognize other hazards present when nail guns are used

Introduction

Nail guns are powerful, easy to operate, and boost productivity for nailing tasks. They are also responsible for an estimated 37,000 emergency room visits each year. Severe nail gun injuries have led to construction worker deaths.

Nail gun injuries are common in residential construction. About two-thirds of these injuries occur in framing and sheathing work. Injuries also often occur in roofing and exterior siding and finishing. How likely are nail gun injuries? A study of apprentice carpenters found that:

- 2 out of 5 were injured using a nail gun during their 4 years of training.
- 1 out of 5 were injured twice.
- 1 out of 10 were injured three or more times.[3]

More than half of reported nail gun injuries are to the hand and fingers. One-quarter of these hand injuries involve structural damage to tendons, joints, nerves, and bones. After hands, the next most often injured are the leg, knee, thigh, foot, and toes. Less common are injuries to the forearm or wrist, head and neck, and trunk. Serious nail gun injuries to the spinal cord, head, neck, eye, internal organs, and bones have been reported. Injuries have resulted in paralysis, blindness, brain damage, bone fractures, and death.

This section is for residential home builders and construction contractors, subcontractors, and supervisors and will give construction employers & workers the information they need to prevent nail gun injuries. Types of triggers and key terms are described. The section highlights what is known about nail gun injuries, including the parts of the body most often injured and the types of severe injuries that have been reported. Common causes of nail gun injuries are discussed and six practical steps that contractors can take to prevent these injuries are described. These are:

1) Use full sequential trigger nail guns;

2) Provide training;

3) Establish nail gun work procedures;

4) Provide personal protective equipment (PPE);

5) Encourage reporting and discussion of injuries and close calls; and

6) Provide first aid and medical treatment.

The guidance includes actual workplace cases along with a short section on other types of nail gun hazards and sources of additional information.

TRIGGERS

Nail gun safety starts with understanding the various trigger mechanisms. Here is what you need to know:

HOW TRIGGERS DIFFER

All nailers rely on two basic controls: a finger trigger and a contact safety tip located on the nose of the gun. Trigger mechanisms can vary based on: 1) the order in which the controls are activated, and 2) whether the trigger can be held in the squeezed position to discharge multiple nails OR if it must be released and then squeezed again for each individual nail. Combining these variations gives four kinds of triggers. Some nail guns have a selective trigger switch which allows the user to choose among two or more trigger systems. Each trigger type is described below along with a summary of how the controls are activated.

Full Sequential trigger

This is the safest type of nail gun trigger. This trigger will only fire a nail when the controls are activated in a certain order. First, the safety contact tip must be pushed into the work piece, then the user squeezes the trigger to discharge a nail. Both the safety contact tip and the trigger must be released and activated again to fire a second nail. Nails cannot be bump fired. Also known as singleshot trigger, restrictive trigger, or trigger fire mode.

- **Single nail:** Push safety contact, then squeeze trigger
- **Multiple nails:** Release both safety contact and trigger and repeat process

Contact trigger

Fires a nail when the safety contact and trigger are activated in any order. You can push the safety contact tip first and then squeeze the trigger, or you can squeeze the trigger first and then push the safety contact tip. If the trigger is kept squeezed, a nail will be driven each time the safety contact is pushed in. All nails can be bump fired. Also known as bump trigger, multi-shot trigger, successive trigger, dual-action, touch trip, contact trip, and bottom fire.

- **Single nail:** Push safety contact, then squeeze trigger, or squeeze trigger, then push safety contact
- **Multiple nails:** Squeeze and hold trigger, then push safety contact to fire one nail, move and push safety contact again to fire additional nails

Single Sequential trigger

Like the full sequential trigger, this trigger will only fire a nail when the controls are activated in a certain order. First, the safety contact tip must be pushed into the work piece. Then, the user squeezes the trigger to discharge a nail. To fire a second nail, only the trigger must be released. The safety contact tip can stay pressed into the work piece. Nails cannot be bump fired.

- **Single nail:** Push safety contact, then squeeze trigger
- **Multiple nails:** Release trigger, move tool, and squeeze trigger to fire additional nail

Single Actuation trigger

Like the contact trigger, this trigger will fire a single nail when the safety contact and trigger are activated in any order. A second nail can be fired by releasing the trigger, moving the tool and squeezing the trigger again without releasing the safety contact tip. Note that some manufacturers refer to these triggers as “single sequential triggers”, but they are different. The first nail can be bump fired with a single actuation trigger but not with a true single sequential trigger.

- **Single nail:** Push safety contact, squeeze trigger, or squeeze trigger, then push safety contact to fire
- **Multiple nails:** Release trigger, move tool, and squeeze trigger to fire additional nail

Other trigger terms

The International Staple, Nail and Tool Association (ISANTA) voluntary standard includes technical definitions for trigger "actuation systems". Tool manufacturers have names for trigger modes such as "intermittent operation method" or "precision placement driving". Contractors and workers use their own names for triggers and operating modes such as "single shot" and "multi-shot".

The bottom line: contractors should check the tool label and manual for manufacturer-specific trigger names and operating information.

HOW DO NAIL GUN INJURIES HAPPEN?

There are seven major risk factors that can lead to a nail gun injury. Understanding them will help you to prevent injuries on your jobsites.

UNINTENDED NAIL DISCHARGE FROM DOUBLE FIRE.

OCCURS WITH CONTACT TRIGGERS.

The Consumer Product Safety Commission (CPSC) found that contact trigger nailers are susceptible to double firing, especially when trying to accurately place the nailer against the work piece. They found that a second unintended firing can happen faster than the user is able to react and release the trigger. Unintended nails can cause injuries. Double fire can be a particular problem for new workers who may push hard on the tool to compensate for recoil. It can also occur when the user is working in an awkward position, such as in tight spaces where the gun doesn't have enough space to recoil. The recoil of the gun itself can even cause a non-nail injury in tight spaces if the nail gun hits the user's head or face.

UNINTENDED NAIL DISCHARGE FROM KNOCKING THE SAFETY CONTACT WITH THE TRIGGER SQUEEZED.

OCCURS WITH CONTACT AND SINGLE ACTUATION TRIGGERS.

Nail guns with contact and single actuation triggers will fire if the trigger is being held squeezed and the safety contact tip gets knocked or pushed into an object or person by mistake. For example, a framer might knock his leg going down a ladder or bump into a co-worker passing through a doorway. Contact trigger nailers can release multiple nails and single actuation trigger nailers can release a single nail to cause injury.

Holding or carrying contact trigger or single actuation trigger nail guns with the trigger squeezed increases the risk of unintended nail discharge. Construction workers tend to keep a finger on the trigger because it is more natural to hold and carry an 8-pound nail gun using a full, four-finger grip. Tool manufacturers, however, do warn against it.

NAIL PENETRATION THROUGH LUMBER WORK PIECE.

OCCURS WITH ALL TRIGGER TYPES

Nails can pass through a work piece and either hit the worker's hand or fly off as a projectile (airborne) nail. A blow-out nail is one example. Blow-outs can occur when a nail is placed near a knot in the wood. Knots involve a change in wood grain, which creates both weak spots and hard spots that can make the nail change direction and exit the work piece. Nail penetration is especially a concern for placement work where a piece of lumber needs to be held in place by hand. If the nail misses or breaks through the lumber it can injure the non-dominant hand holding it.

NAIL RICOCHET AFTER STRIKING A HARD SURFACE OR METAL FEATURE.

Occurs with ALL trigger types.

When a nail hits a hard surface, it has to change direction and it can bounce off the surface, becoming a projectile. Wood knots and metal framing hardware are common causes of ricochets. Problems have also been noted with ricochets when nailing into dense laminated beams. Ricochet nails can strike the worker or a co-worker to cause an injury.

MISSING THE WORK PIECE.

OCCURS WITH ALL TRIGGER TYPES.

Injuries may occur when the tip of the nail gun does not make full contact with the work piece and the discharged nail becomes airborne. This can occur when nailing near the edge of a work piece, such as a plate. Positioning the safety contact is more difficult in these situations and sometimes the fired nail completely misses the lumber. Injuries have also occurred when a nail shot through plywood or oriented strand board sheeting missed a stud and became airborne.

AWKWARD POSITION NAILING.

OCCURS WITH ALL TRIGGER TYPES.

Note: Unintended discharges are a concern in awkward position work with CONTACT and SINGLE ACTUATION triggers.

Nailing in awkward positions where the tool and its recoil are more difficult to control may increase the risk of injury. These include toe-nailing, nailing above shoulder height, nailing in tight quarters, holding the nail gun with the non-dominant hand, nailing while on a ladder, or nailing when the user's body is in the line of fire (nailing towards yourself). Toe-nailing is awkward because the gun cannot be held flush against the work piece. Nailing from a ladder makes it difficult to position the nail gun accurately. Nailing beyond a comfortable reach distance from a ladder, elevated work platform, or leading edge also places the user at risk for a fall.

BYPASSING SAFETY MECHANISMS.

OCCURS WITH ALL TRIGGER TYPES.

Bypassing or disabling certain features of either the trigger or safety contact tip is an important risk of injury. For example, removing the spring from the safety contact tip makes an unintended discharge even more likely. Modifying tools can lead to safety problems for anyone who uses the nail gun. Nail gun manufacturers strongly recommend against bypassing safety features, and voluntary standards prohibit modifications or tampering.7 OSHA's Construction standard at 29 CFR 1926.300(a) requires that all hand and power tools and similar equipment, whether furnished by the employer or the employee shall be maintained in a safe condition.

SIX STEPS TO NAIL GUN SAFETY

Use the full sequential trigger

The full sequential trigger is always the safest trigger mechanism for the job. It reduces the risk of unintentional nail discharge and double fires—including injuries from bumping into co-workers.

- At a minimum, provide full sequential trigger nailers for placement work where the lumber needs to be held in place by hand. Examples include building walls and nailing blocking, fastening studs to plates and blocks to studs, and installing trusses. Unintended nail discharge is more likely to lead to a hand or arm injury for placement work compared to flat work, where the lumber does not need to be held in place by hand. Examples of flat work include roofing, sheathing, and subflooring.

- Consider restricting inexperienced employees to full sequential trigger nail guns starting out. Some contractors using more than one type of trigger on their jobs color-code the nail guns so that the type of trigger can be readily identified by workers and supervisors.

- Some contractors have been reluctant to use full sequential triggers fearing a loss of productivity. How do the different types of triggers compare?

The one available study had 10 experienced framers stick-build two identical small (8 ft x 10 ft) wood structures—one using a sequential trigger nail gun and one using a contact trigger nail gun. Small structures were built in this study so that there would be time for each carpenter to complete two sheds.

Average nailing time using the contact trigger was 10% faster, which accounted for less than 1% of the total building time when cutting and layout was included.11 However, in this study the trigger type was less important to overall productivity than who was using the tool; this suggests productivity concerns should focus on the skill of the carpenter rather than on the trigger.

Although the study did not evaluate framing a residence or light commercial building, it shows that productivity is not just about the trigger. The wood structures built for the study did include common types of nailing tasks (flat nailing, through nailing, toe-nailing) and allowed comparisons for both total average nailing time and overall project time. The study did not compare productivity differences for each type of nailing task used to build the sheds.

Provide training

Both new and experienced workers can benefit from safety training to learn about the causes of nail gun injuries and specific steps to reduce them. Be sure that training is provided in a manner that employees can understand. Here is a list of topics for training:

- How nail guns work and how triggers differ.
- Main causes of injuries – especially differences among types of triggers.
- Instructions provided in manufacturer tool manuals and where the manual is kept.
- Hands-on training with the actual nailers to be used on the job. This gives each employee an opportunity to handle the nailer and to get feedback on topics such as:
    - How to load the nail gun
    - How to operate the air compressor
    - How to fire the nail gun
    - How to hold lumber during placement work
    - How to recognize and approach ricochet-prone work surfaces
    - How to handle awkward position work (e.g., toenailing and work on ladders)
    - How best to handle special risks associated with contact and single actuation triggers such as nail gun recoil and double fires. For example, coach new employees on how to minimize double fires by allowing the nail gun to recoil rather than continuing to push against the gun after it fires.
- What to do when a nail gun malfunctions.
- Training should also cover items covered in the following sections of the guidance, such as company nail gun work procedures, personal protective equipment, injury reporting, and first aid and medical treatment.

Establish nail gun work procedures

Contractors should develop their own nail gun work rules and procedures to address risk factors and make the work as safe as possible. Examples of topics for contractor work procedures include but are not limited to the following:

Do's...

- Make sure that tool manuals for the nailers used on the job are always available on the jobsite.
- Make sure that manufacturers' tool labels and instructions are understood and followed. Check tools and power sources before operating to make sure that they are in proper working order. Take

broken or malfunctioning nail guns out of service immediately.

● Set up operations so that workers are not in the line of fire from nail guns being operated by co-workers.

● Check lumber surfaces before nailing. Look for knots, nails, straps, hangers, etc. that could cause recoil or ricochet.

● Use a hammer or positive placement nailer when nailing metal joinery or irregular lumber.

● For placement work, keep hands at least 12 inches away from the nailing point at all times. Consider using clamps to brace instead of your hands.

● Always shoot nail guns away from your body and away from coworkers.

● Always disconnect the compressed air when:

- Leaving a nailer unattended;
- Travelling up and down a ladder or stairs;
- Passing the nail gun to a coworker;
- Clearing jammed nails;
- Performing any other maintenance on the nail gun.

● Recognize the dangers of awkward position work and provide extra time and precautions:

- Use a hammer if you cannot reach the work while holding the nailer with your dominant hand.
- Use a hammer or reposition for work at face or head height. Recoil is more difficult to control and could be dangerous.
- Use a hammer or full sequential trigger nailer when working in a tight space. Recoil is more difficult to control and double fires could occur with contact triggers.
- Take extra care with toe-nailing. Nail guns can slip before or during firing because the gun cannot be held flush against the work piece. Use a nail gun with teeth on the safety contact to bite into the work piece to keep the gun from slipping during the shot. Use the trigger to fire only after the safety contact piece is positioned.

● Recognize the dangers of nail gun work at height and provide extra time and precautions:

- Set up jobs to minimize the need for nailing at height.
- Consider using scaffolds instead of ladders.
- If work must be done on ladders, use full sequential trigger nailers to prevent nail gun injuries which could occur from bumping a leg while climbing up or down a ladder.
- Position ladders so you don't have to reach too far. Your belt buckle should stay between the side rails when reaching to the side.
- Maintain three points of contact with the ladder at all times to prevent a fall—this means that clamps may need to be used for placement work. Holding a nailer in one hand and the work piece with the other provides only two points of contact (your feet). Reaching and recoil can make you lose your balance and fall. Falls, especially with contact trigger nailers, can result in nail gun injuries.

Don'ts...

● Never bypass or disable nail gun safety features. This is strictly prohibited. Tampering includes removing the spring from the safety-contact tip and/or tying down, taping or otherwise securing the trigger so it does not need to be pressed. Tampering increases the chance that the nail gun will fire unintentionally both for the current user and anyone else who may use the nail gun. Nail gun manufacturers strongly recommend against tampering and OSHA requires that tools be maintained in a safe condition. There is NO legitimate reason to modify or disable a nail gun safety device.

- Encourage your workers to keep their fingers off the trigger when holding or carrying a nail gun. If this is not natural, workers should use a full sequential nail gun or set down the nailer until they begin to nail again.
- Never lower the nail gun from above or drag the tool by the hose. If the nail-gun hose gets caught on something, don't pull on the hose. Go find the problem and release the hose.
- Never use the nailer with the nondominant hand.

Provide Personal Protective Equipment (PPE)

Safety shoes, which help protect workers' toes from nail gun injuries, are typically required by OSHA on residential construction sites. In addition, employers should provide, at no cost to employees, the following protective equipment for workers using nail guns:

- Hard hats
- High Impact eye protection – safety glasses or goggles marked ANSI Z87.1
- Hearing protection – either earplugs or earmuffs

Encourage reporting and discussion of injuries and close calls

Studies show that many nail gun injuries go unreported. Employers should ensure that their policies and practices encourage reporting of nail gun injuries. Reporting helps ensure that employees get medical attention (see #6 below). It also helps contractors to identify unrecognized job site risks that could lead to additional injuries if not addressed. Injuries and close calls provide teachable moments that can help improve crew safety.

If you have a safety incentive program, be sure that it does not discourage workers from reporting injuries. Employers that intentionally underreport work-related injuries will be in violation of OSHA's injury and illness recordkeeping regulation.

Provide first aid and medical treatment

Employers and workers should seek medical attention immediately after nail gun injuries, even for hand injuries that appear to be minimal. Studies suggest that 1 out of 4 nail gun hand injuries can involve some type of structural damage such as bone fracture.13 Materials such as nail strip glue or plastic or even clothing can get embedded in the injury and lead to infection. Barbs on the nail can cause secondary injury if the nail is removed incorrectly. These complications can be avoided by having workers seek immediate medical care.

OTHER NAIL GUN RELATED HAZARDS

Air pressure.

Pneumatic tools and compressor use are regulated under OSHA's Construction standard at 29 CFR 1926.302(b). The provisions in this standard that are relevant for nail guns are provided below.

(1) Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming accidentally disconnected.

Note: Use of a quick disconnect with a pull-down sleeve to meet acceptable to meet this requirement. It is composed of a male fitting (connector) and female fitting (coupling) that has a sleeve which must be pulled away from the end of the hose to separate the two fittings to prevent the tool from becoming accidentally disconnected.

(2) All pneumatically driven nailers, staplers, and other similar equipment provided with automatic fastener feed, which operate at more than 100 p.s.i. pressure at the tool shall have a safety device on the muzzle to prevent the tool from ejecting fasteners, unless the muzzle is in contact with the work surface.

(3) The manufacturer's safe operating pressure for hoses, pipes, valves, filters, and other fittings shall not be exceeded.

(4) The use of hoses for hoisting or lowering tools shall not be permitted.

Noise.

Pneumatic nail guns produce short (less than a tenth of a second in duration) but loud "impulse" noise peaks: one from driving the nail and one from exhausting the air. Most nail gun manufacturers recommend that users wear hearing protection when operating a nailer.

Available information indicates that nail gun noise can vary depending on the gun, the work piece, air pressure, and the work setting. The type of trigger system does not appear to affect the noise level. Peak noise emission levels for several nailers ranged from 109 to 136 dBA.15,16 These loud short bursts can contribute to hearing loss. Employers should provide hearing protection in the form of earplugs or muffs and ensure that they are worn correctly. Employers should also ask about noise levels when buying nail guns—studies have identified ways to reduce nail gun noise and some manufacturers may incorporate noise reduction features.

Note: OSHA's standard for exposure to continuous noise levels (29 CFR 1926.52) addresses both the noise level and the duration of exposure. In this standard, workers exposed for 15 minutes at 115 A-weighted decibels (dBA) have the same exposure as workers exposed for 8 hours at 90 dBA.

The NIOSH and OSHA limit for impulse noise is 140 decibels: above this level a single exposure can cause instant damage to the ear.

NIOSH recommends that an 8-hour exposure should not exceed 85 dBA and a one-second exposure should not exceed 130 dBA without using hearing protection.

Musculoskeletal disorders.

Framing nail guns can weigh up to 8 pounds and many framing jobs require workers to hold and use these guns for long periods of time in awkward hand/arm postures. Holding an 8-pound weight for long periods of time can lead to musculoskeletal symptoms such as soreness or tenderness in the fingers, wrist, or forearm tendons or muscles. These symptoms can progress to pain, or in the most severe cases, inability to work. No studies have shown that one trigger type is any more or less likely to cause musculoskeletal problems from long periods of nail gun use. If use of a nail gun is causing musculoskeletal pain or symptoms of musculoskeletal disorders, medical care should be sought.

CONCLUSION

Nail gun injuries are painful. Some cause severe injuries or death. Nail gun injuries have been on the rise along with the increased popularity of these powerful tools. These injuries can be prevented, and more and more contractors are making changes to improve nail gun safety.

Take a look at your practices and use this course to improve safety on your job sites. Working together with tool gun manufacturers, safety and health professionals, and other organizations, we can reduce nail gun injuries.

REFERENCES

Nail Gun Safety: A guide for Construction Workers:
https://www.osha.gov/Publications/NailgunFinal_508_02_optimized.pdf

OSHA laws and Regulations:
https://www.osha.gov/law-regs.html

OSHA Regulations (Standards – 29 CFR) Construction:
https://www.osha.gov/pls/oshaweb/owasrch.searc

h_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=Construction

OSHA Publications:
https://www.osha.gov/pls/publications/publication.html

Workplace Safety – Construction Site Safety

LEARNING OBJECTIVES

Upon completion of this module, the student will be able to:

6. Review common nail gun injuries and what can be done to mitigate the hazards
7. Identify the various trigger mechanisms and their controls
8. Discuss why nail gun injuries happen including the seven major risk factors associated
9. Understand the six steps to nail gun safety used to mitigate nail gun risks
10. Recognize other hazards present when nail guns are used

Introduction

Nearly 6.5 million people work at approximate-ly 252,000 construction sites across the nation on any given day. The fatal injury rate for the construction industry is higher than the national average in this category for all industries.

Potential hazards for workers in construction include:

- Falls (from heights);
- Trench collapse;
- Scaffold collapse;
- Electric shock and arc flash/arc blast;
- Failure to use proper personal protective equipment; and
- Repetitive motion injuries.

HAZARDS & SOLUTIONS

For construction, the 10 OSHA standards most frequently included in the agency's citations in FY 2004 were:

1. Scaffolding
2. Fall protection (scope, application, definitions)
3. Excavations (general requirements)
4. Ladders
5. Head protection
6. Excavations (requirements for protective systems)
7. Hazard communication
8. Fall protection (training requirements)
9. Construction (general safety and health provisions)
10. Electrical (wiring methods, design and protection)

SCAFFOLDING

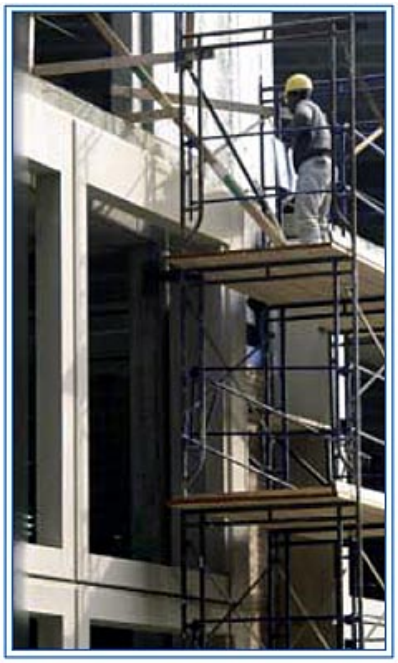
Hazard:

When scaffolds are not erected or used properly, fall hazards can occur. About 2.3 million construction workers frequently work on scaffolds. Protecting these workers from scaffold-related accidents would prevent an estimated 4,500 injuries and 50 fatalities each year.

Solutions:

- Scaffold must be sound, rigid and sufficient to carry its own weight plus four times the maximum intended load without settling or displacement. It must be erected on solid footing.

- Unstable objects, such as barrels, boxes, loose bricks or concrete blocks must not be used to support scaffolds or planks.
- Scaffold must not be erected, moved, dismantled or altered except under the supervision of a competent person.
- Scaffold must be equipped with guardrails, midrails and toeboards.
- Scaffold accessories such as braces, brackets, trusses, screw legs or ladders that are damaged or weakened from any cause must be immediately repaired or replaced.



- Scaffold platforms must be tightly planked with scaffold plank grade material or equivalent.
- A "competent person" must inspect the scaffolding and, at designated intervals, reinspect it.
- Rigging on suspension scaffolds must be inspected by a competent person before each shift and after any occurrence that could affect structural integrity to ensure that all connections are tight and that no damage to the rigging has occurred since its last use.
- Synthetic and natural rope used in suspension scaffolding must be protected from heat-producing sources.
- Employees must be instructed about the hazards of using diagonal braces as fall protection.
- Scaffold can be accessed by using ladders and stairwells.
- Scaffolds must be at least 10 feet from electric power lines at all times..

FALL PROTECTION?

Hazard:

Each year, falls consistently account for the greatest number of fatalities in the construction industry. A number of factors are often involved in falls, including unstable working surfaces, misuse or failure to use fall protection equipment and human error. Studies have shown that using guardrails, fall arrest systems, safety nets, covers and restraint systems can prevent many deaths and injuries from falls.

Solutions:

- Consider using aerial lifts or elevated platforms to provide safer elevated working surfaces;
- Erect guardrail systems with toeboards and warning lines or install control line systems to protect workers near the edges of floors and roofs;
- Cover floor holes; and/or
- Use safety net systems or personal fall arrest systems (body harnesses).

LADDERS

Hazard:

Ladders and stairways are another source of injuries and fatalities among construction workers. OSHA estimates that there are 24,882 injuries and as many as 36 fatalities per year due to falls on stairways and ladders used in construction. Nearly half of these injuries were serious enough to require time off the job.

Solutions:

- Use the correct ladder for the task.
- Have a competent person visually inspect a ladder before use for any defects such as:
    - Structural damage, split/bent side rails, broken or missing rungs/steps/cleats and missing or damaged safety devices;
    - Grease, dirt or other contaminants that could cause slips or falls;
    - Paint or stickers (except warning labels) that could hide possible defects
- Make sure that ladders are long enough to safely reach the work area.
- Mark or tag ("Do Not Use") damaged or defective ladders for repair or replacement, or destroy them immediately.
- Never load ladders beyond the maximum intended load or beyond the manufacturer's rated capacity.
- Be sure the load rating can support the weight of the user, including materials and tools.
- Avoid using ladders with metallic components near electrical work and overhead power lines.

STAIRWAYS

Hazard:

Slips, trips and falls on stairways are a major source of injuries and fatalities among construction workers.

Solutions:

- Stairway treads and walkways must be free of dangerous objects, debris and materials.
- Slippery conditions on stairways and walkways must be corrected immediately.
- Make sure that treads cover the entire step and landing.
- Stairways having four or more risers or rising more than 30 inches must have at least one handrail.

TRENCHING

Hazard:

Trench collapses cause dozens of fatalities and hundreds of injuries each year. Trenching deaths rose in 2003.

Solutions:

- Never enter an unprotected trench.
- Always use a protective system for trenches feet deep or greater.
- Employ a registered professional engineer to design a protective system for trenches 20 feet deep or greater.
- Protective Systems:
    - Sloping to protect workers by cutting back the trench wall at an angle inclined away from the excavation not steeper than a height/depth ratio of 11 2 :1, according to the sloping requirements for the type of soil.
    - Shoring to protect workers by installing supports to prevent soil movement for trenches that do not exceed 20 feet in depth.
    - Shielding to protect workers by using trench boxes or other types of supports to prevent soil cave-ins.
- Always provide a way to exit a trench--such as a ladder, stairway or ramp--no more than 25 feet of lateral travel for employees in the trench.

- Keep spoils at least two feet back from the edge of a trench.
- Make sure that trenches are inspected by a competent person prior to entry and after any hazard-increasing event such as a rainstorm, vibrations or excessive surcharge loads.

Table: Allowable Slopes

Soil type	Height/ Depth ratio	Slope angle
Stable Rock (granite or sandstone)	Vertical	90º
Type A (clay)	¾:1	53º
Type B (gravel, silt	1:1	45º
Type C (sand)	1½:1	34º
Type A (short-term) (For a maximum excavation depth of 12 ft.)	½:1	63º

CRANES

Hazard:

Significant and serious injuries may occur if cranes are not inspected before use and if they are not used properly. Often these injuries occur when a worker is struck by an overhead load or caught within the crane's swing radius. Many crane fatalities occur when the boom of a crane or its load line contact an overhead power line.

Solutions:

- Check all crane controls to insure proper operation before use.
- Inspect wire rope, chains and hook for any damage.
- Know the weight of the load that the crane is to lift.
- Ensure that the load does not exceed the crane's rated capacity.
- Raise the load a few inches to verify balance and the effectiveness of the brake system.
- Check all rigging prior to use; do not wrap hoist ropes or chains around the load.
- Fully extend outriggers.
- Do not move a load over workers.
- Barricade accessible areas within the crane's swing radius.
- Watch for overhead electrical distribution and transmission lines and maintain a safe working clearance of at least 10 feet from energized electrical lines.

HAZARD COMMUNICATION

Hazard:

Failure to recognize the hazards associated with chemicals can cause chemical burns, respiratory problems, fires and explosions.

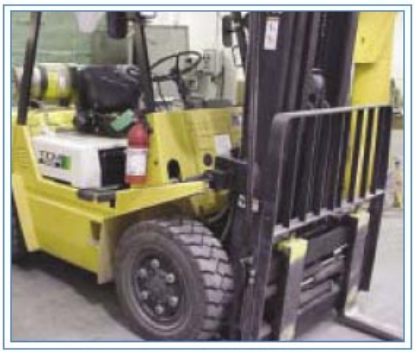
Solutions:

- Maintain a Material Safety Data Sheet (MSDS) for each chemical in the facility.
- Make this information accessible to employees at all times in a language or formats that are clearly understood by all affected personnel.
- Train employees on how to read and use the MSDS.
- Follow manufacturer's MSDS instructions for handling hazardous chemicals.
- Train employees about the risks of each hazardous chemical being used.
- Provide spill clean-up kits in areas where chemicals are stored.
- Have a written spill control plan.
- Train employees to clean up spills, protect themselves and properly dispose of used materials.
- Provide proper personal protective equipment and enforce its use.
- Store chemicals safely and securely.

FORKLIFTS

Hazard:

Approximately 100 employees are fatally injured and approximately 95,000 employees are injured every year while operating powered industrial trucks. Forklift turnover accounts for a significant number of these fatalities.



Solutions:

- Train and certify all operators to ensure that they operate forklifts safely.
- Do not allow any employee under 18 years old to operate a forklift.
- Properly maintain haulage equipment, including tires.
- Do not modify or make attachments that affect the capacity and safe operation of the forklift without written approval from the forklift's manufacturer.
- Examine forklift truck for defects before using.
- Follow safe operating procedures for picking up, moving, putting down and stacking loads.
- Drive safely--never exceed 5 mph and slow down in congested or slippery surface areas.
- Prohibit stunt driving and horseplay.
- Do not handle loads that are heavier than the capacity of the industrial truck.
- Remove unsafe or defective forklift trucks from service.
- Operators shall always wear seatbelts.
- Avoid traveling with elevated loads.
- Assure that rollover protective structure is in place.
- Make certain that the reverse signal alarm is operational and audible above the surrounding noise level

HEAD PROTECTION

Hazard:

Serious head injuries can result from blows to the head.

Solution:

- Be sure that workers wear hard hats where there is a potential for objects falling from above, bumps to their heads from fixed objects, or accidental head contact with electrical hazards.

SAFETY CHECKLISTS

The following checklists may help you take steps to avoid hazards that cause injuries, illnesses and fatalities. As always, be cautious and seek help if you are concerned about a potential hazard.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Eye and Face Protection

- ✓ Safety glasses or face shields are worn anytime work operations can cause foreign objects getting into the eye such as during welding, cutting, grinding, nailing (or when working with concrete and/or harmful chemicals or when exposed to flying particles).
- ✓ Eye and face protectors are selected based on anticipated hazards.
- ✓ Safety glasses or face shields are worn when exposed to any electrical hazards including work on energized electrical systems.

Foot Protection

- ✓ Construction workers should wear work shoes or boots with slip-resistant and puncture-resistant soles.
- ✓ Safety-toed footwear is worn to prevent crushed toes when working around heavy equipment or falling objects.

Hand Protection

- ✓ Gloves should fit snugly.
- ✓ Workers wear the right gloves for the job (for example, heavy-duty rubber gloves for concrete work, welding gloves for welding, insulated gloves and sleeves when exposed to electrical hazards).

Head Protection

- ✓ Workers shall wear hard hats where there is a potential for objects falling from above, bumps to their heads from fixed objects, or of accidental head contact with electrical hazards.
- ✓ Hard hats are routinely inspected for dents, cracks or deterioration.
- ✓ Hard hats are replaced after a heavy blow or electrical shock.
- ✓ Hard hats are maintained in good condition.

SCAFFOLDING

- ✓ Scaffolds should be set on sound footing.
- ✓ Damaged parts that affect the strength of the scaffold are taken out of service.
- ✓ Scaffolds are not altered.
- ✓ All scaffolds should be fully planked.
- ✓ Scaffolds are not moved horizontally while workers are on them unless they are designed to be mobile and workers have been trained in the proper procedures.
- ✓ Employees are not permitted to work on scaffolds when covered with snow, ice, or other slippery materials.
- ✓ Scaffolds are not erected or moved within 10 feet of power lines.
- ✓ Employees are not permitted to work on scaffolds in bad weather or high winds unless a competent person has determined that it is safe to do so.
- ✓ Ladders, boxes, barrels, buckets or other makeshift platforms are not used to raise work height.
- ✓ Extra material is not allowed to build up on scaffold platforms.
- ✓ Scaffolds should not be loaded with more weight than they were designed to support.

ELECTRICAL SAFETY

- ✓ Work on new and existing energized (hot) electrical circuits is prohibited until all power is shut off and grounds are attached.
- ✓ An effective Lockout/Tagout system is in place.
- ✓ Frayed, damaged or worn electrical cords or cables are promptly replaced.
- ✓ All extension cords have grounding prongs.
- ✓ Protect flexible cords and cables from damage. Sharp corners and projections should be avoided.
- ✓ Use extension cord sets used with portable electric tools and appliances that are the three-wire type and designed for hard or extra-hard service. (Look for some

of the following letters imprinted on the casing: S, ST, SO, STO.)

- ✓ All electrical tools and equipment are maintained in safe condition and checked regularly for defects and taken out of service if a defect is found.
- ✓ Do not bypass any protective system or device designed to protect employees from contact with electrical energy.
- ✓ Overhead electrical power lines are located and identified.
- ✓ Ensure that ladders, scaffolds, equipment or materials never come within 10 feet of electrical power lines.
- ✓ All electrical tools must be properly grounded unless they are of the double insulated type.
- ✓ Multiple plug adapters are prohibited.

FLOOR AND WALL OPENINGS

- ✓ Floor openings (12 inches or more) are guarded by a secured cover, a guardrail or equivalent on all sides (except at entrances to stairways).
- ✓ Toeboards are installed around the edges of permanent floor openings (where persons may pass below the opening).

ELEVATED SURFACES

- ✓ Signs are posted, when appropriate, showing the elevated surface load capacity.
- ✓ Surfaces elevated more than 48 inches above the floor or ground have standard guardrails.
- ✓ All elevated surfaces (beneath which people or machinery could be exposed to falling objects) have standard 4-inch toeboards.
- ✓ A permanent means of entry and exit with handrails is provided to elevated storage and work surfaces.
- ✓ Material is piled, stacked or racked in a way that prevents it from tipping, falling, collapsing, rolling or spreading.

HAZARD COMMUNICATION

- ✓ A list of hazardous substances used in the workplace is maintained and readily available at the worksite.
- ✓ There is a written hazard communication program addressing Material Safety Data Sheets (MSDS), labeling and employee training.
- ✓ Each container of a hazardous substance (vats, bottles, storage tanks) is labeled with product identity and a hazard warning(s) (communicating the specific health hazards and physical hazards).
- ✓ Material Safety Data Sheets are readily available at all times for each hazardous substance used.
- ✓ There is an effective employee training program for hazardous substances.

CRANE SAFETY

- ✓ Cranes and derricks are restricted from operating within 10 feet of any electrical power line.
- ✓ The upper rotating structure supporting the boom and materials being handled is provided with an electrical ground while working near energized transmitter towers.
- ✓ Rated load capacities, operating speed and instructions are posted and visible to the operator.
- ✓ Cranes are equipped with a load chart.

- ✓ The operator understands and uses the load chart.
- ✓ The operator can determine the angle and length of the crane boom at all times.
- ✓ Crane machinery and other rigging equipment is inspected daily prior to use to make sure that it is in good condition.
- ✓ Accessible areas within the crane's swing radius are barricaded.
- ✓ Tag lines are used to prevent dangerous swing or spin of materials when raised or lowered by a crane or derrick.
- ✓ Illustrations of hand signals to crane and derrick operators are posted on the job site.
- ✓ The signal person uses correct signals for the crane operator to follow.
- ✓ Crane outriggers are extended when required.
- ✓ Crane platforms and walkways have antiskid surfaces.
- ✓ Broken, worn or damaged wire rope is removed from service.
- ✓ Guardrails, hand holds and steps are provided for safe and easy access to and from all areas of the crane.
- ✓ Load testing reports/certifications are available.
- ✓ Tower crane mast bolts are properly torqued to the manufacturer's specifications.
- ✓ Overload limits are tested and correctly set.
- ✓ The maximum acceptable load and the last test results are posted on the crane.
- ✓ Initial and annual inspections of all hoisting and rigging equipment are performed and reports are maintained.
- ✓ Only properly trained and qualified operators are allowed to work with hoisting and rigging equipment.

FORKLIFTS

- ✓ Forklift truck operators are competent to operate these vehicles safely as demonstrated by their successful completion of training and evaluation.
- ✓ No employee under 18 years old is allowed to operate a forklift.
- ✓ Forklifts are inspected daily for proper condition of brakes, horns, steering, forks and tires.
- ✓ Powered industrial trucks (forklifts) meet the design and construction requirements established in American National Standards Institute (ANSI) for Powered Industrial Trucks, Part II ANSI B56.1-1969.
- ✓ Written approval from the truck manufacturer is obtained for any modification or additions which affect capacity and safe operation of the vehicle.
- ✓ Capacity, operation and maintenance instruction plates, tags or decals are changed to indicate any modifications or additions to the vehicle.
- ✓ Battery charging is conducted in areas specifically designated for that purpose.
- ✓ Material handling equipment is provided for handling batteries, including conveyors, overhead hoists or equivalent devices.
- ✓ Reinstalled batteries are properly positioned and secured in the truck.

- ✓ Smoking is prohibited in battery charging areas.
- ✓ Precautions are taken to prevent open flames, sparks or electric arcs in battery charging areas.
- ✓ Refresher training is provided and an evaluation is conducted whenever a forklift operator has been observed operating the vehicle in an unsafe manner and when an operator is assigned to drive a different type of truck.
- ✓ Load and forks are fully lowered, controls neutralized, power shut off and brakes set when a powered industrial truck is left unattended.
- ✓ There is sufficient headroom for the forklift and operator under overhead installations, lights, pipes, sprinkler systems, etc.
- ✓ Overhead guards are in place to protect the operator against falling objects.
- ✓ Trucks are operated at a safe speed.
- ✓ All loads are kept stable, safely arranged and fit within the rated capacity of the truck.
- ✓ Unsafe and defective trucks are removed from service.

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http://www.osha.gov/SLTC/residential/index.html

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http://www.osha.gov/Publications/scor1926.pdf

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http://www.osha.gov/Publications/trench/trench_safety_tips_card.pdf

Quiz Questions

The following forty (40) question quiz will test the student's comprehension of the course. The student must past this quiz with a score greater than 70%.

Question 1: Why is fall protection so important, especially in the construction industry?

a) Risk mitigation techniques are difficult to accomplish
b) High turn-over rate among employees in this industry
c) Falls are the leading cause of fatalities in this industry
d) All of the above

Question 2: Which of the following scenarios require fall protection?

a) Working at heights six feet above the lower level
b) Working above any dangerous machinery or similar hazards
c) Working by reaching ten inches or more below the level of surface the worker is on if the surface is above six feet or more
d) All of the above

Question 3: What are some examples of fall protection requirements for Leading Edges?

a) Hard hat
b) Monitoring system without warning line
c) Guardrail or safety net systems
d) Non-slip shoes

Question 4: True or False: When engaged in roofing work on low-slope roofs 50 feet or less in width, the use of a safety monitoring system without a warning line system is not permitted.

a) True
b) False

Question 5: _____ are barriers erected to prevent workers from falling to lower levels.

a) Midrails
b) Screens
c) Guardrail systems
d) Architectural panels

Question 6: Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members must be capable of withstanding a force of at least ___ applied in any downward or outward direction at any point along the midrail or other member.

a) 150lbs
b) 50lbs
c) 100lbs
d) 75lbs

Question 7: True or False: Safety nets need to be inspected at least once a week for wear, damage, or deterioration of components such as net connection points.

a) True
b) False

Question 8: Each worker at the edge of an excavation ___ feet or more must be protected from falling by some sort of guardrail system.

a) 7
b) 10
c) 8
d) 6

Question 9: Toe-boards are effective means to prevent falling objects. What are the minimum standards?

a) Capable of handling a force greater than 25lbs
b) Openings no larger than 2 inches in its greatest dimension
c) Clearance of no more than 3/8 inch above the walking or working surface
d) 3.5 inches tall from their top edge to the level of the walking or working surface

Question 10: Regarding training in fall protection, what are the employer's responsibilities? Choose the best answer.

a) To provide fall protection training
b) To post hazardous OSHA informative signs at the job site
c) To provide fall protection training including verifying that training with a written certification record
d) Perform surprise audits of employees to ensure fall protection is being utilized

Question 11: What is Silicosis?

a) A eye infection
b) A handheld masonry saw
c) A type of sand
d) A serious lung disease

Question 12: Which of the following construction materials may present a silica risk?

a) Asphalt filler
b) Caulk and Putty
c) Roofing granules
d) All of the above

Question 13: How does someone become "at risk" for developing Silicosis?

a) Breathing in dust
b) When a production of dusts containing silica gets released into the air from crushing, grinding or cutting materials with quartz in it.
c) Walking past a construction site
d) By working with a VDC system

Question 14: Of all the methods to mitigate the airborne silica risk while cutting, what method is most effective?

a) Vacuum Dust Collection (VDC) systems
b) Dust barriers
c) Exhaust fans
d) Wet cutting

Question 15: What is not an effective dust control device when used by itself to manage dust?

a) A Fan
b) VDC
c) Ventilation Booths
d) None of the above

Question 16: What is strongly discouraged to use to clean surfaces or clothing?

a) Compressed Air
b) Wet methods
c) Showering
d) HEPA Filtered vacuum

Question 17: According to Silica Dust Control Measures, what method does not eliminate exposure, but may help reduce the amount of dust in the employees breathing area?

a) Employee Positioning
b) Using a smaller grinding wheel
c) Utilizing construction methods and techniques that minimize the amount of grinding required
d) All of the above

Question 18: While using a handheld drill, a worker quickly realizes he can reduce the airborne silica risk by using this?

a) Holding his breath while the drill is in use
b) Breathing in through his nose and exhaling through his mouth
c) Using a fan to blow the debris away from him
d) A damp barrier which is pressed against the working surface

Question 19: To reduce airborne risks at a particular hazardous construction site, a supervisor installs several garden hoses with mist attachments. He notices a huge cloud of dust every time a worker disposes of materials in a dumpster. The supervisor can quickly reduce this risk by what means?

a) Placing the OSHA silica exposure hazard sign adjacent the dumpster
b) Informing the worker to wear the proper PPE
c) Misting the dumpster and keeping the materials inside moist
d) Having dumpster moved upwind to the site

Question 20: What is the most effective method in keeping silica levels below hazardous levels?

a) Wet Method
b) Dry Method
c) Full Face piece respirator equipped with N, R, or P-95 filter
d) Both A and C

Question 21: More than half of reported nail gun injuries are to the hand and fingers. What is the next most often injured part of the body? (reference paragraph Introduction)

a) Forearm or wrist
b) Head and neck
c) Eyes and internal organs
d) Leg, knee, thigh, foot and toes

Question 22: Nail gun safety starts with understanding _____.

a) The various trigger mechanisms
b) Nail gun injuries
c) Provided training
d) Nail gun work procedures

Question 23: How many kinds of triggers are there?

a) 4
b) 5
c) 3
d) 2

Question 24: A new inexperienced worker is hired for a residential home framing crew, what nail gun should he be given to use?

a) A weaker cordless nail gun
b) A nail gun with a single actuation trigger
c) A nail gun with a single sequential trigger
d) A nail gun with a full sequential trigger

Question 25: According to The International Staple, Nail and Tool Association, contractors should check what?

a) Trigger terms
b) Tool label and manual for manufacturer – specific trigger names and operating information
c) How nail gun injuries happen
d) Nothing

Question 26: What bad technique do workers get accustomed while carrying around a nail gun?

a) Holding the nail gun with a four-finger grip, with a finger on the trigger
b) Holding the nail gun with two hands
c) Holstering the nail gun on their tool belt
d) Holding the nail gun with their more dominate hand

Question 27: According to CPSC, what is the common name for unintended firing?

a) Double down
b) Triple threat
c) Double firing
d) Ricochet

Question 28: When can double firing occur?

a) When placing a contact trigger nailer against the work piece
b) When pushing to hard on the tool to compensate for recoil
c) Working in an awkward position, such as a tight space
d) All of the above

Question 29: How many steps should be addressed for nail gun safety?

a) 10
b) 6
c) 20
d) 15

Question 30: Employers should provide to their employees using nail guns with which type of personal protective equipment (PPE)? (reference paragraph Provide Personal Protective Equipment (PPE))

a) Hard hats
b) Safety glasses
c) Hearing protection
d) All of the above

Question 31: Scaffolds must be at least ____ feet from electric power lines at all times.

a) 10
b) 5
c) 20
d) 100

Question 32: True or False. Falls consistently account for the greatest number of fatalities in the construction industry.

a) True
b) False

Question 33: The maximum allowable slope angle on a 15 ft deep excavation of silt is,

a) 53°
b) 34°
c) 63°
d) 45°

Question 34: What does MSDS mean?

a) Material Safety Data Sheet
b) Maintenance Service and Disposal Standards
c) Manual Safety Data Specification
d) Material Specification for Disposal Standards

Question 35: True or False. Employees must be at least 16 years of age to operate a forklift.

a) True
b) False

Question 36: Lockout/Tagout is the means to,

a) Control electrical hazards
b) Control crane operations
c) Prevent slips, trips, and falls
d) Ensure compliance to OSHA standards

Question 37: Which is not a Personal Protective Equipment (PPE)?

a) Hearing Aid
b) Steel-Toe Boots
c) Hard-hat
d) Face shield

Question 38: Elevated surfaces, which may expose people or machinery beneath it to falling debris, should have a standard,

a) Falling object sign posted
b) Hard hat required sign posted
c) 12" Toe-board
d) 4" Toe-board

Question 39: True or False. Illustrations of hand signals to crane and derrick operators must be posted on the job site.

a) True
b) False

Question 40: A company or business with VPP approval,

a) Qualifies for tax credit incentives for 100% compliance
b) Is recognized for excellent safety and health management systems
c) Is exempt from certain OHSA standards
d) Meets the minimum standard for all OHSA regulations