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WORKSHOP INTRODUCTION

Construction work is inherently dangerous, and working at elevation significantly increases the risk of falls and injuries. Since most construction sites are strewn with fall hazards, contractors, supervisors, and workers make a joint effort to prevent falls and to protect personnel from injury when falls inevitably occur. This workshop explains why falls and similar accidents take place on construction sites and describes the government and industry rules, requirements, and regulations intended to protect workers from falls and fall-related injuries. It also outlines the elements of an effective construction site fall safety program.

In addition to commonsense safety precautions, these elements include the proper assessment and control of fall hazards through the proper use of guardrails, safety nets, and hole covers, as well as administrative controls such as the establishment of controlled access zones. They also include the active fall safety systems that workers are required to use when passive systems are insufficient. Active fall safety systems typically consist of secure anchorages, full-body harnesses and connectors, as well as properly trained descent and rescue crews. Personal fall arrest systems and other fall safety equipment must be correctly selected, inspected, and worn. The workshop lists and details special safety factors that must be taken into consideration when using common construction equipment such as manufactured, job-built, and fixed ladders, as well as stairways, scaffolds, and mobile elevated work platforms.

OBJECTIVES

Upon successful completion of this workshop, the participant should be able to:

1. Describe the difference between fall prevention and fall protection, and explain why both are essential for the safety of workers.
2. Demonstrate the ability to assess fall hazards using a standard Hazard Inspection Checklist.
3. Explain how guardrail systems, safety nets, and hole covers are used to protect workers.
4. Describe measures that can be taken to minimize the risk of dropped-object accidents.
5. Demonstrate the ability to identify and establish a secure fall protection anchorage.
6. Describe the Foreign Material Exclusion process and explain why these precautions are often necessary.
7. List and describe the four fundamental requirements that must be met by every fall protection system.
8. List and describe five key elements of a construction site emergency response plan.
9. Demonstrate the ability to properly inspect, don, doff, and store a full-body harness.
10. Demonstrate the ability to determine the appropriate fall protection systems required for a specific scaffold application.
11. Demonstrate the ability to determine the appropriate fall protection systems required for a specific MEWP application.
12. Demonstrate the ability to properly select and inspect ladders required for a specific application.
13. List and describe the safety requirements for temporary stairs and job-built stair systems.
14. Explain how handrails, guardrails, and stair rails are installed and used to protect workers from falls.

CHAPTER

1 Working Safely at Heights

INTRODUCTION

Contractors and workers must put safety first in every situation. Falls rank among the most common construction-related accidents. Because an unprotected fall from any height will likely cause severe or even fatal injuries, falls rank among the most dangerous types of accident. This chapter explains why falls and other accidents often happen at work and how both passive and active techniques can be used to guard against them.

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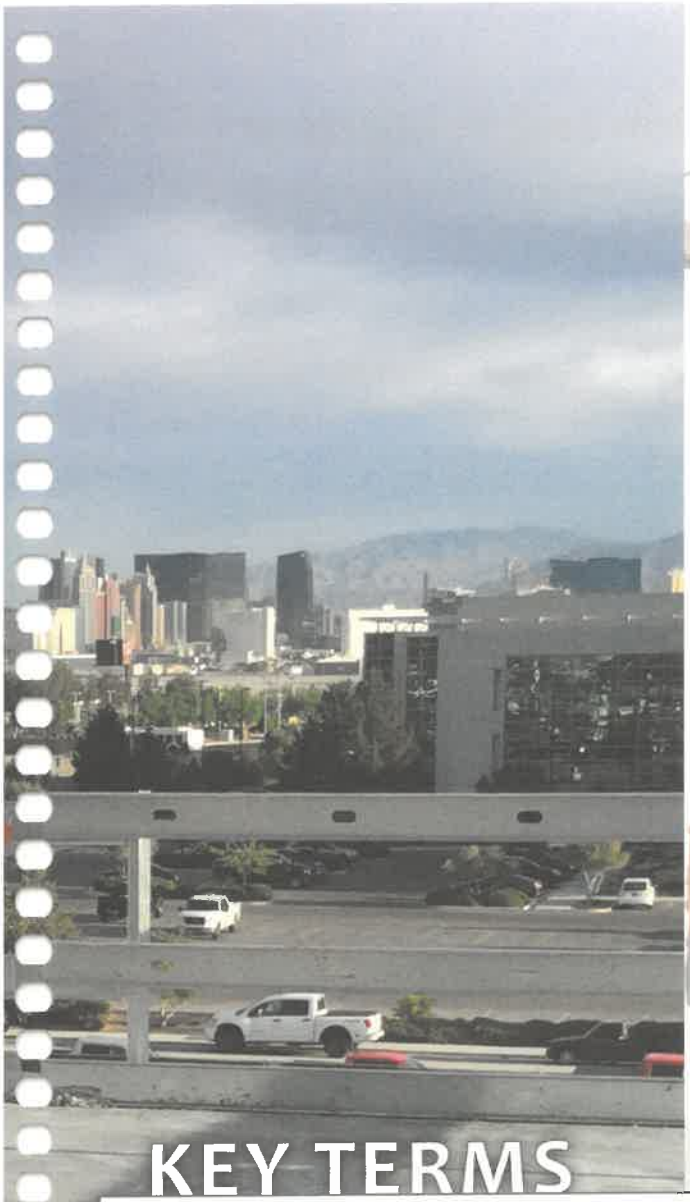


OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. List four reasons fall-related accidents occur.
2. Describe the difference between fall prevention and fall protection, and explain why each are essential for the safety of workers.
3. List and describe four key government or private agencies in the United States and Canada that establish safety rules, regulations, and standards.
4. List and describe three actions an employer is required to take to keep workers safe.
5. Define the terms "competent person" and "qualified person" and explain the difference.
6. Explain the meaning and importance of the slogan "Plan, Provide, and Train."
7. Explain why prompt rescue of a fallen worker is crucial.

KEY TERMS

Key Terms are in order of appearance.

fall prevention use of safety systems such as guardrails or barriers, or techniques such as the assembly of roof systems on the ground instead of at elevation, to eliminate or reduce the likelihood of falls

fall protection use of controls such as fall restraint or arrest systems designed to prevent falls or to protect against injury in the event of a fall

passive fall protection fall safety system relying on the use of guardrails, fences, or similar static barriers

active fall protection safety system that relies on the individual worker to perform a personal action to prevent falls or protect against fall-related injuries

personal fall arrest system (PFAS) safety system consisting of an anchorage, connectors, and full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall

leading edge unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surface, such as a deck, that changes location as additional floor or roof decking of formwork sections are placed, formed, or constructed

competent person individual capable of identifying existing or predictable hazards in working conditions or surroundings and who has been given authority to take corrective measures

qualified person individual who, by possession of recognized degrees, certificates, or professional standing; or by extensive knowledge, training, and experience; has demonstrated the ability to resolve safety issues or solve other work-related problems

1 Fall Prevention and Protection

Construction work is always dangerous and contractors, supervisors, and workers must make safety their foremost concern. Failure to do so may have costly or even tragic consequences. For contractors, these may include severe or even fatal accidents that can disrupt schedules, increase expenses, and possibly lead to the loss of valuable employees or major contracts. For workers, the consequences can be far worse and may include loss of income, crippling injuries, permanent disabilities, or death. Falls rank among the most common and dangerous types of construction accidents, accounting for approximately one-third of all construction-related fatalities. Although OSHA's statistics show minor variations each year, the top ten safety citations are remarkably consistent, with fall protection historically ranking at the top of that list. For this reason, protecting workers from falls must be a key element of every construction safety program.

Why Are Falls So Common?

Many factors can lead to construction site falls and fall-related injuries. These may include lack of proper safety training, lack of required safety equipment, defective safety equipment, or improper installation and use of safety equipment. Other contributing factors may include poor work safety practices such as standing on moving forklifts, neglecting to reinstall guardrails after completing work, walking on joists or unguarded planks between levels, leaving gaps and holes uncovered, and failure to clear away debris. Most fall-related construction site injuries are caused by falls from elevation.

Why Are Falls So Dangerous?

Dictionaries define the term "fall" as a sudden, unanticipated descent in space driven by gravity. Because construction workers must often work at heights, the consequences of falls can be tragic. It takes most people about one-third of a second to realize that they are falling, and another one-third of a second for the body to react. During those two-thirds of a second, a body can fall seven feet and already may be moving fast enough to cause a serious injury. To make matters worse, most construction falls are from height. Obviously, the further the fall, the greater the impact, and the greater the likelihood of injury or death.

Fall Safety

Employers, contractors, and workers must do whatever they can to eliminate or reduce the likelihood of falls and fall-related injuries. Fall safety programs may incorporate either or both of two complementary approaches. The first and most effective approach is to prevent falls from happening in the first place. This is referred to as fall prevention. **Fall prevention** involves the use of safety systems such as guardrails or barriers, or techniques, such as the assembly of roof systems on the ground instead of at elevation, to

eliminate or reduce the possibility of falls. Since a fall that never happens can do no harm, this is a highly effective way to prevent fall-related injuries and fatalities. However, fall prevention is not always feasible.

In many instances, the risk of falling cannot entirely be eliminated. In such cases, workers and others likely to be exposed to such risks must be protected in other ways. **Fall protection** involves the use of controls such as fall restraint or arrest systems designed to prevent falls or to protect against injury in the event of a fall. It may also include the use of administrative controls, such as written safety policies and training intended to protect project personnel or others from falls. In most cases, fall protection is implemented when working at height, near the edge of a pit or hole, or on a steep surface. Fall protection is generally divided into two categories: passive and active.

Passive Fall Protection **Passive fall protection** is a fall safety system relying on the use of guardrails, fences, or similar *static barriers*. Examples of such systems are shown in Figure 1. A passive system does not require the

FIGURE 1

Passive fall protection systems

Guardrail system

Wire rope guardrail system

FIGURE 2
Using a PFAS

worker or other at-risk person to take any personal action to be protected from a fall. Instead, the system is intended as a fail-safe to protect personnel. It is the responsibility of the owner, employer, contractor, and employee to install and maintain passive fall protection systems. These systems may be engineered as part of the existing structure.

Active Fall Protection **Active fall protection** is a safety system that relies on the individual worker to perform a personal action to prevent falls or to protect against fall-related injuries. These actions might include wearing a full-body harness and connecting it to a secure anchorage point. A common type of active fall protection is a **personal fall arrest system** (**PFAS**) which consists of a secure anchorage point, connectors, and full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall. Figure 2 shows an example of a PFAS in use.

Determining the Best Type of Fall Protection

The fall protection equipment selected for a job will be determined by a variety of factors. Before selecting the equipment, certain questions must be answered. For example, how high is the work? Will it be done on a roof, leading edge, or scaffold? A **leading edge** is an unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surface, such as a deck, that changes location as additional floor or roof decking of formwork sections are placed, formed, or constructed. What safety equipment is already present at the work site? How adequate are the passive fall protection systems at the site? If an active fall protection system will be required, is the worker thoroughly trained in its use? Employers or

contractors often develop a fall protection plan that will list the types of fall protection gear that will be needed and where and when it must be used at the construction site. The plan should include the following information:

- list of fall hazards at the work site
- fall protection system to be used
- anchors for lanyards and other fall arrest equipment
- clearance distance below the work area
- procedures for assembling and maintaining fall protection systems
- rescue procedures

SELF CHECK

1. List four reasons falls are so common.
2. How long does it usually take for people to realize they are falling?
3. Describe the difference between the terms fall prevention and fall protection.
4. Explain the difference between passive and active fall protection.
5. List five key elements of a fall protection plan.

2 Why Falls and Other Accidents Happen

Falls and other accidents do not just happen. Although it may not always be possible to determine why they occur, accidents always have a cause. Construction accidents can often be linked to human error of some sort, including a task that has been performed improperly or an obvious hazard that has been overlooked. This does not mean that someone must be blamed for every work-related mishap; it means that accidents and injuries frequently can and should be prevented. By far, the best way to deal with an accident is to ensure it never happens.

In order to help prevent accidents, workers must have an understanding as to why they happen in the first place. Sometimes the cause of a work-related accident can be traced to one or more common mistakes or oversights. These may include complacency, lack of proper training, unsafe work habits, failure to follow safety rules and regulations, or failure to identify and eliminate dangerous work-site hazards. A poor attitude can also be an important factor.

Complacency

People tend to be especially cautious when performing an activity for the first time. This is because the activity is unfamiliar and they are concerned with doing it right while avoiding injury. The worker will grow more confident with repeated performance of the activity. While confidence is typically a good thing, it can be dangerous if it leads to complacency. An increased

level of comfort with any activity or process can reduce vigilance and cause workers to become complacent and careless. This can lead to accidents and injuries.

Complacency must be actively avoided, especially when the work is repetitious. Unsafe practices should never be allowed to slip into any routine. Having worked at a jobsite without injury for a long period of time does not justify a lack of attentiveness or care. Workers must remain constantly and fully aware of jobsite hazards, including fall hazards. These should be reviewed on a regular basis, along with safety practices and procedures that should be followed.

Lack of Training

Poorly trained workers will be a danger not only to themselves, but to others as well. Most construction workers are well trained and experienced in the use of the tools and techniques required to efficiently perform assigned tasks. This makes them much safer workers, but specific safety training is also necessary. For instance, workers should be trained in the use of all required safety equipment and personal protective equipment (PPE). Figure 3 shows workers in a safety training class.

FIGURE 3
Workers in safety training

SAFETY TIP

Horseplay and practical jokes on a jobsite can lead to dangerous outcomes. Always take the job at hand seriously.

Unsafe Work Habits

The cause of many accidents and injuries can be traced to unsafe work habits. These may include the improper use of tools, machinery, or safety equipment, or the improper or incomplete application of established and proven techniques. If workers forget or ignore their training, they will inevitably place themselves and others in jeopardy. For the safety of the worker and everyone involved in a project, all such dangerous habits must be identified and eliminated.

Working in a rushed or hurried manner will increase the possibility of an accident occurring. Workers must be productive, but the drive for productivity must never replace care and safety as a jobsite priority. Hurried workers will almost always develop unsafe habits that may expose them to hazards and increase the likelihood of accidents and injuries. The following situation depicts what may happen if an unsafe shortcut is taken by a worker.

FALL AWARENESS SCENARIO

A 27-year-old laborer was fatally injured when he fell through an unguarded roof opening while repairing the rubber roof membrane of a college sports coliseum. The victim and his foreman were repairing the membrane after it had been sliced open to provide access to the underlying roof structure. The victim had been cleaning the existing membrane while his foreman, working behind him, was completing the patch. The victim had progressed beyond the peak of the arched roof, out of sight of the foreman, and had disconnected his fall protection lanyard from the lifelines. For an unknown reason, the victim stepped on an exposed ceiling tile which gave way, allowing the victim to fall 90 feet to the gym floor. Workers inside the gym saw the victim fall and hit the floor. One of the workers, an EMT, immediately went to the victim and began CPR while another worker called 911. The campus emergency medical squad (EMS) responded within eight minutes and transported the victim to a local emergency room where he was pronounced dead.

- How could this incident have been prevented?
- Do you know anyone who has fallen from a roof?
- Discuss what can happen to the victim's family after the fall.

Failure to Follow Safety Rules

Government safety regulations, rules, and requirements are not intended to complicate the lives of contractors and their workers; they are meant to help prevent dangerous accidents and injuries, protect lives and property, and extend careers. When properly followed, they can make a construction site a much safer place to work. Construction workers should follow all relevant local, state, federal (OSHA), and provincial (OH&S) regulations. Since these regulations are not all the same, the contractor and worker must follow the most stringent regulations that apply to a given locale or work situation. Contractors or project managers may enforce additional safety rules, and these must be followed as well.

Construction Site Hazards

Many construction site accidents and injuries are caused by exposure to hazards that could easily be corrected, including mobile elevating work platforms or walkways without proper guardrails. Typical construction sites can contain many such hazards, some obvious and others not easily

detected. These may include obstacles and other objects such as open pits or trenches that may cause a worker to trip or fall, poorly designed passages with blind corners, improperly placed cables and extension cords, and countless other dangers. Figure 4 shows examples of construction site fall hazards. Many of these hazards can be identified and eliminated before work begins on a construction site. However, some such hazards will be overlooked, while others may be created as the work progresses. Continuously watching for hazards, reporting them, and determining how to eliminate or guard against them is the responsibility of every worker on the job.

FIGURE 4
Construction site fall hazards

SELF CHECK

1. What is the best way to deal with an accident?
2. List four common human errors or mistakes that may lead to accidents.
3. Explain why complacency is a threat to worker safety.
4. Explain why rushed or hurried work is so dangerous.
5. List four examples of the many fall hazards a worker will likely encounter on a construction site.

3 Fall Protection Standards, Regulations, and Requirements

Employers are required by law to protect employees by providing them with a safe place to work. A thorough effort must be made to identify hazards and safety issues, and these must be eliminated or otherwise properly addressed. The employer's responsibility in matters of safety is not just a legal concern, but a moral one as well. The consequences of an accident can be severe and can last a lifetime. They may include debilitating injuries or even the loss of a worker's life, and no one wants that on their conscience.

However, safety is a joint responsibility in which the worker and the employer must accept an equal share. Workers must follow safety rules, best practices, and regulations that have been set by local, state, federal, and provincial laws or by the contractor, and must remain constantly vigilant on the jobsite.

Human Toll

Work-related accidents, including those that take place on construction sites, can exact a heavy human toll. Although some injuries caused by an accident may be minor, they can also be serious and even fatal. They can restrict injured workers to beds or wheelchairs, and make it impossible to work or support their families financially. People can lose their livelihoods and their homes in this way, and it happens more often than many may think. When someone is injured or killed on a construction site, the ramifications can extend to every member of the worker's family, and they can last a lifetime.

Regulations, Requirements, and Standards

Because the consequences of an accident can be so severe, government and private agencies have established a host of safety regulations, requirements, and standards to protect workers. Among the most detailed and stringent are those related to fall safety. This is because falls are so common and so often cause severe injuries or death. Any work that must be done at elevation, such as construction work that makes use of scaffolds, will be heavily regulated by local, state, provincial, or federal governments. This type of work also will be covered by standards that have been established by private industrial agencies that receive no government funding or sponsorship, such as the American National Standards Institute (ANSI). In many cases, additional site-specific rules may be established by contractors or other employers and these are often more stringent than government or private agency regulations. All such safety rules and regulations, whether established by government entities, private agencies, or contractors, must be carefully followed.

It is extremely important for employers and workers to become familiar with relevant rules, regulations, and standards. It is the legal responsibility of the employer to ensure that these rules, regulations, and standards are followed by workers on the jobsite; their safety depends on it. Construction safety rules, regulations, and standards are created, periodically revised, and published in both printed and digital form by the following entities.

Occupational Safety and Health Administration (OSHA) Founded in 1970, the Occupational Safety and Health Administration (OSHA) is the best known and most important work-safety agency in the United States. It promotes on-the-job safety by mandating safe work practices and environments. OSHA regulations and requirements that deal with fall protection can be accessed through publications such as *OSHA Standards for the*

Construction and General Industry either in print or on the internet at www.osha.gov. Figure 5 shows one example of an OSHA safety publication.

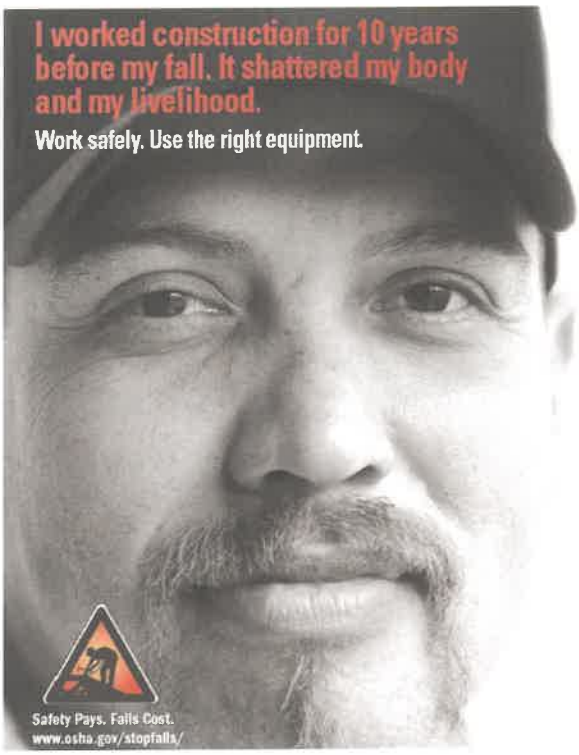


FIGURE 5
OSHA safety publication

Occupational Health and Safety Acts and Regulations (OH&S) Canada's Occupational Health and Safety Acts and Regulations (OH&S) are established and enforced by federal and provincial entities. These agencies focus on ensuring safe and healthful workplaces and work practices within their own jurisdictions. They set and enforce construction safety regulations and standards intended to protect both workers and the general public.

American National Standards Institute (ANSI) A private, nonprofit agency founded in 1918, the American National Standards Institute (ANSI) sets and administers a voluntary system of industrial and work standards. The system is intended to ensure that materials and equipment in the United States are used or operated according to minimum safe standards. ANSI standards relate to a wide variety of safety equipment, from the helmets worn when riding bicycles to the harnesses and lanyards worn for fall protection. The standards related to construction fall protection can be accessed through publications such as The Catalog of American National Standards, available in print or on the internet at www.ansi.org.

Canadian Standards Association (CSA) The private nonprofit agency that administers public safety policies, testing, and procedures in Canada is called the Canadian Standards Association (CSA). The CSA is accredited by the Standards Council, a Canadian federal agency. The CSA tests products for compliance to national and international standards and issues certification marks for qualified products. Certification marks tell potential customers and users that a formal process involving examination, testing, and follow-up inspection have been used to evaluate a product and that the product complies with applicable standards for safety and performance. A typical CSA certification mark is shown in Figure 6.

FIGURE 6
CSA certification mark

United States Army Corps of Engineers (USACE) A United States federal agency under the authority of the Department of Defense and a major U.S. Army command, the United States Army Corps of Engineers (USACE) is one of the world's largest public engineering, design, and construction management operations. The USACE sets and enforces its own, separate rules, regulations, and standards, and these apply to all USACE projects and facilities. USACE regulations covering fall protection are especially strict. The *USACE Safety and Health Requirements Manual, EM 385-1-1* states that "every facility having personnel working at heights, exposed to fall hazards, and using fall protection equipment is responsible for establishing, implementing, and managing a fall protection program that includes the identification and elimination or control of fall hazards." Figure 7 shows a USACE construction project.

FIGURE 7
USACE project

Plan, Provide, and Train

Safety consciousness provides the best protection from accidents and injuries. Workers must be mindful of hazards and familiar with all relevant safety rules and regulations enforced by local authorities or private agencies, and follow them to the letter. Since falls are such a common type of accident, it is especially important to raise awareness among workers and employers concerning common fall hazards in construction, and how falls from ladders, scaffolds, and roofs can be prevented. The "Plan, Provide, and Train" approach, shown in Figure 8, can be used to help provide awareness and methods of prevention. This three-step approach has been featured in major OSHA fall safety awareness campaigns. The three key elements of this approach are discussed below.

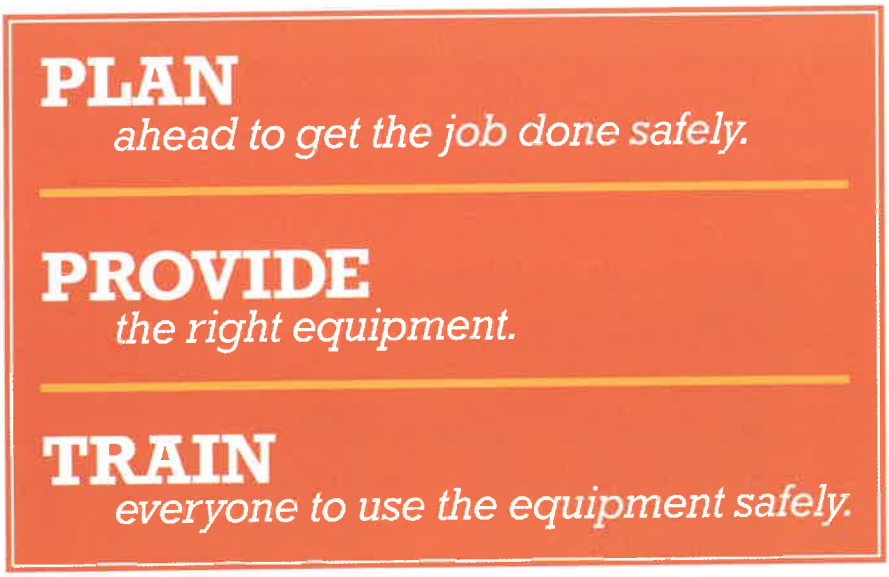


FIGURE 8
Plan, Provide, and Train

PLAN Ahead Careful planning is required to get a job done safely. Before a fall safety plan can be developed, several key questions must be answered. For instance, the height at which the work will be performed, how it will be performed, and all the tasks involved must be determined. The safety equipment required for each task must be identified and made readily available at the construction site. For example, before a roofing job is begun, all existing or potential fall hazards such as holes, skylights, and leading edges must be taken into consideration.

The appropriate fall prevention or fall protection methods must be selected. These may include personal fall arrest systems (PFASs), warning line systems, anchorages, or any of a variety of other safety systems. If no appropriate systems are suitable for the job, it may be necessary to implement a formal and comprehensive fall protection plan as required by government agencies. Figure 9 shows a foreman and crew planning and selecting the appropriate fall prevention and protection methods.

FIGURE 9
Planning ahead

FIGURE 10
Using provided PFAS

PROVIDE the Right Equipment Anyone who works six feet or more above the ground or lower levels will be at risk of serious injury or death in the event of a fall. To protect these workers, employers must provide the proper equipment, such as the appropriate ladders, scaffolds, and safety gear. When work must be done at dangerous elevations, such as roofing installation, the contractor may provide and require workers to use personal fall arrest systems (PFASs). In this case, the contractor will supply a harness that can be tied off to an anchor. The PFAS must fit properly and must be inspected on a regular basis. Figure 10 shows a construction worker using a PFAS.

TRAIN Everyone Every person on a construction site who may need to use safety equipment must be thoroughly trained in its proper use. Employers must also train workers to recognize hazards on the job and to protect themselves accordingly. Figure 11 shows a safety training meeting regarding the proper use of fall protection.

FIGURE 11
Safety training meeting

Jobsite Safety Management

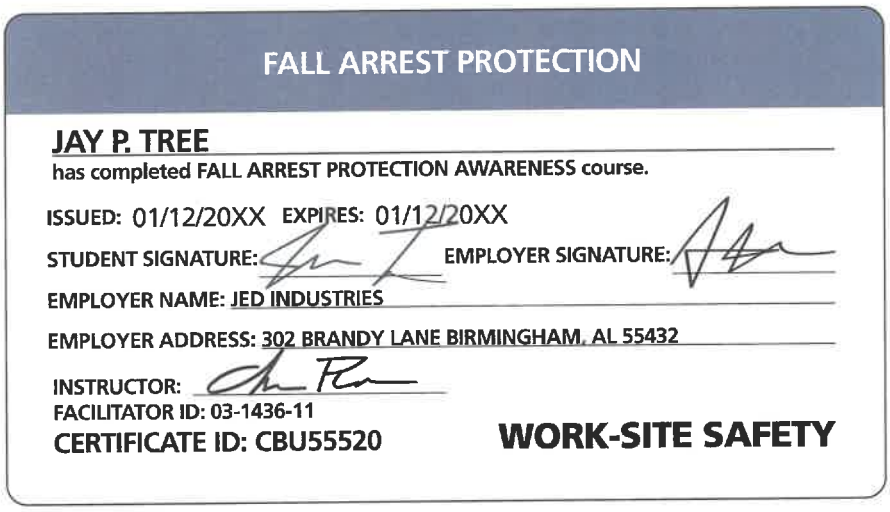
An essential part of any fall prevention and protection plan is the designation of an individual with authority to make key safety-related decisions at the jobsite. While contractors and other members of a project management team share responsibility for maintaining safe working conditions for project personnel, they cannot always be present on the construction site to make decisions concerning safety. For this reason, OSHA requires that someone at the work site be designated a **competent person**—an individual capable of identifying existing or predictable hazards in working conditions or surroundings and who has been given authority to take corrective measures. Employers are responsible for designating competent

persons, who may be either supervisors or employees, so long as they are properly trained and qualified. The duties of the competent person may include developing, implementing, and supervising a fall protection plan, selecting the best equipment for a specific application, ensuring the proper installation of fall protection equipment, inspecting fall protection equipment, and ensuring workers are trained to use the equipment properly.

Sometimes confusion exists concerning the difference between a competent person and a qualified person. A **qualified person** is an individual who, by possession of recognized degrees, certificates, or professional standing; or by extensive knowledge, training, and experience; has demonstrated the ability to resolve safety issues or solve other work-related problems. No matter how much expertise a qualified person may possess, they do not have the authority to make work-site safety decisions unless they are also a designated competent person appointed by the contractor.

The Importance of Proper Safety Training

An untrained or poorly trained worker is a dangerous worker. Without the proper training, workers endanger themselves, their coworkers, and others on a construction site. Employers are responsible for ensuring that all employees receive fall protection training and that the training is properly verified and documented. In accordance with safety rules and regulations, employers must verify worker training by preparing a written certification record, such as the one shown in Figure 12. The record must contain the name of the worker, the dates of the training, and the signature of either the person who conducted the training or the employer.


FALL ARREST PROTECTION

JAY P. TREE
has completed FALL ARREST PROTECTION AWARENESS course.

ISSUED: 01/12/20XX EXPIRES: 01/12/20XX

STUDENT SIGNATURE: EMPLOYER SIGNATURE:

EMPLOYER NAME: JED INDUSTRIES

EMPLOYER ADDRESS: 302 BRANDY LANE BIRMINGHAM, AL 55432

INSTRUCTOR:

FACILITATOR ID: 03-1436-11

CERTIFICATE ID: CBU55520

WORK-SITE SAFETY

FIGURE 12
Sample certification record

OSHA Training Requirements and Standards Adequate worker training covering a range of fall safety concerns and issues is required by OSHA. For instance, OSHA regulations require that all workers be trained under close supervision before using any fall protection equipment or techniques. To ensure that workers understand the capabilities and limitations of their personal protective equipment (PPE), live, hands-on training must be provided

FIGURE 13
Hands-on training

to each worker. See Figure 13. OSHA requires that all such fall safety training be conducted by a competent person. The training should be site-specific and should be repeated periodically as a review and to provide additional practice in the use of PPE. OSHA training standards for general industry are published in 29 CFR 1910.30 and for the construction industry in 29 CFR 1926.503. These standards require workers to be trained in the following:

- identification of potential fall hazards and the procedures for minimizing these hazards
- correct procedures for installing, inspecting, operating, maintaining, and disassembling personal fall protection systems
- correct use of personal fall protection systems and equipment, including proper hook-up, anchoring, and tie-off techniques
- proper care, inspection, storage, and use of equipment in accordance with the manufacturer's instructions

USACE Requirements and Standards The United States Army Corps of Engineers (USACE) has its own, separate fall safety training requirements. These may differ in significant ways from OSHA requirements, so contractors and workers should be familiar with them before beginning a USACE project. Table 1 lists key USACE fall safety training requirements.

TABLE 1 ***USACE fall safety training requirements***

Position Title	Type of Training (Reference ANSI/ASSE Z359.2)	Length and Refresher (all training shall be documented)
Fall Protection Program Manager	Working knowledge of current fall protection regulations, requirements, standards, equipment, and systems	1 hour of initial and refresher annually covering fall protection and rescue; can be informational meetings or training sessions
Qualified Person (QP) for Fall Protection	Trained by a QP Trainer in proper inspection, assembly, and use of fall protection equipment and systems that they encounter in their work as a QP	By professional training, qualification, or certification 1-hour annual refresher; can be informational meetings or training sessions

(continued)

TABLE 1 *USACE fall safety training requirements (continued)*

Position Title	Type of Training (Reference ANSI/ASSE Z359.2)	Length and Refresher (all training shall be documented)
Competent Person (CP) for Fall Protection	Trained by a Competent Person or Qualified Person for Fall Protection Trainer	Initial 24 hours of a combination of formal and practical, documented 2-hours of annual refresher; can be informational meetings, training sessions, or a combination of both
End User	Trained by Competent Person for Fall Protection who is qualified in delivering fall protection training	2–8 hours or as appropriate 1-hour annual refresher
Authorized Rescuer	Trained by a Competent Rescue Trainer	2–8 hours or as appropriate 1-hour annual refresher
Competent Rescuer	Trained by a Competent Rescue Trainer	2–8 hours or as appropriate 1-hour annual refresher
Supervisors of End Users and other applicable employees	FP awareness training Familiarization with Standard Operating Procedures (SOP) Local program requirements Proper inspection and record keeping Proper anchoring and tie-off techniques	Local Training plan/briefing and instruction SOP or Web-Based Training

Retraining

All safety training should be documented and the work performance of workers who have received the training should be monitored. This should be done to ensure that the safety training program is effective and that instructions are being properly followed. Trained workers who fail to demonstrate adequate proficiency with fall safety procedures must repeat earlier training. Workers must be retrained under some circumstances, which include the following:

- training deficiencies are noted
- worker performance indicates lack of understanding
- changes in the workplace make previous training obsolete
- changes in the type or design of fall protection systems make previous training obsolete
- changes in rules, regulations, or standards require additional training

SELF CHECK

1. Explain why an employer has both legal and moral responsibilities when it comes to safety on the jobsite.
2. Explain what the United States Army Corps of Engineers (USACE) is and why it is necessary to become familiar with USACE rules, regulations, and standards.
3. What is meant by "Plan, Provide, and Train," and how do these three key elements of a fall safety program benefit workers?
4. Who is responsible for verifying a worker's safety training, and how is this done?
5. List four reasons workers must receive additional safety training.

4 Fall Rescue Requirements

Providing and maintaining a safe work environment is the collective responsibility of owners, contractors, workers, construction site visitors, and everyone involved in a project. Despite the best efforts of all concerned, however, work-related falls and other accidents can, and do, happen. When compared to most other types of on-the-job accidents, falls are more likely to result in serious or even life-threatening injuries. This fact makes it especially important for workers who have fallen to receive prompt assistance and medical treatment. Figure 14 shows a foreman assisting a worker who has fallen. The required assistance and treatment may include the rescue of a worker from an elevated location, such as when a worker has fallen and is suspended in a safety harness. The success of such rescues will depend not only on the courage and determination of those who carry them out, but also on proper training and the existence of a well-conceived emergency response plan that outlines fall rescue procedures.

FIGURE 14
Foreman assisting a fallen worker

Importance of a Prompt Rescue

When workers fall and are suspended in a harness, it is important that they be rescued as quickly as possible. Immediate and effective action is required, as the fallen worker may be injured and in urgent need of medical attention. Other reasons for initiating a prompt rescue may include the following:

- The event that caused the fall may create additional risks that must be addressed.
- Suspended workers may panic if they are not rescued quickly.

- When workers are suspended in their safety harnesses for long periods of time, they may suffer from blood pooling in the lower body, which can lead to a dangerous condition known as suspension trauma.

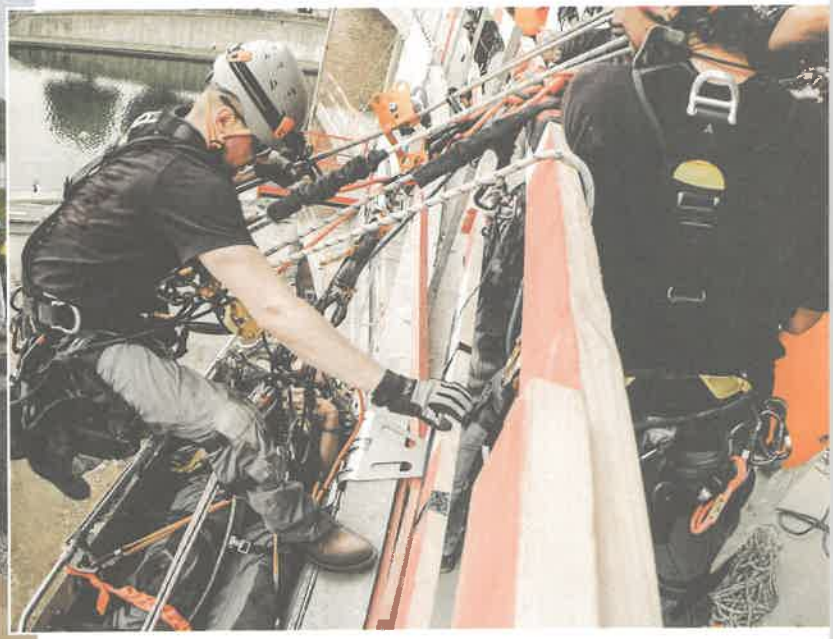
Rescue Training

Workers must know what to do when a coworker falls and must be rescued. Since prompt and appropriate action can save a life or prevent a worker from being permanently disabled, rescue training should be part of every fall safety training program. To make sure workers receive the appropriate safety training, they and other on-site personnel are required to attend a site-specific training session where they will review emergency response procedures and receive instruction on alarms and assembly areas. Figure 15 shows a construction site rescue training session.

This training should include techniques for rescuing a worker who has fallen and is suspended in a harness. In most cases, a crew is designated and specially trained to perform rescues of this type. This crew must know how to use the equipment that is available to them at the jobsite and where it can be found. The crew should review the rescue procedure every two weeks in conjunction with the crane crews who may be needed to help one or more rescuers reach a suspended worker. Figure 16 shows an elevated rescue in progress.

FIGURE 15
Construction site rescue training

FIGURE 16
Elevated rescue



Emergency Response Plan

A well-organized emergency response plan is an essential part of any construction site safety program. The plan should be completed and in place before work at the site begins, and all supervisors and workers should become familiar with the plan during safety training. A typical emergency response plan will include the following elements or steps to be taken in case of an on-site fall or other emergency:

- The site supervisor or designated alternate should be informed of the emergency and take charge.
- Project personnel in the immediate vicinity of the incident are told to stop working while the supervisor evaluates the situation and identifies hazards that could endanger personnel or interfere with rescue efforts.
- The site supervisor or designated personnel summon help.
- The site supervisor calls the site emergency contact number.
- A perimeter is established around the site of the accident to limit further exposure to potential hazards.
- All nonessential or unaffected personnel are either evacuated or told to remain where they are.
- The site supervisor orders everyone at the site to keep communications channels free so they can be used by emergency responders. Most emergency communications will be conducted on a separate frequency or channel that has been designated for emergencies.
- A designated worker is sent to the construction site entrance to meet police, fire, or medical emergency responders and direct them safely to the scene of the accident.
- The site supervisor assembles an emergency rescue team and initiates appropriate rescue procedures.

FIGURE 17
Self-rescue

Standard Rescue Procedures

A variety of safe and effective procedures can be used for the rescue of fallen workers. Several of these are briefly described in this section, but will be covered in greater detail later in the workshop. The procedure chosen will depend on factors such as the relative safety of the procedure, the availability of the necessary equipment and personnel, the location of the fallen worker, and any nearby hazards. The following three procedures are commonly used to rescue fallen personnel.

Self-Rescue Self-rescue will be carried out in 90 percent of rescue situations. A rescuer does not intervene in this type of rescue, but allows the person who fell to climb to safety or use a descending device, as shown in Figure 17.

Mobile Elevating Work Platform (MEWP) Rescue The MEWP is positioned below the suspended worker and one or more rescuers are lifted into

the proper position to provide assistance. The MEWP must have the capacity required to support both the rescuers and the fallen worker. Figure 18 shows a MEWP rescue in progress.

Ladder Rescue When a MEWP is unavailable or cannot be used, the use of a ladder rescue is the preferred alternative. In this case, a ladder of the proper height is positioned so that a rescuer can reach and assist the fallen worker. Figure 19 shows a ladder rescue in progress. The rescuer should be protected by a separate lifeline, if necessary.

Post-Rescue Procedures

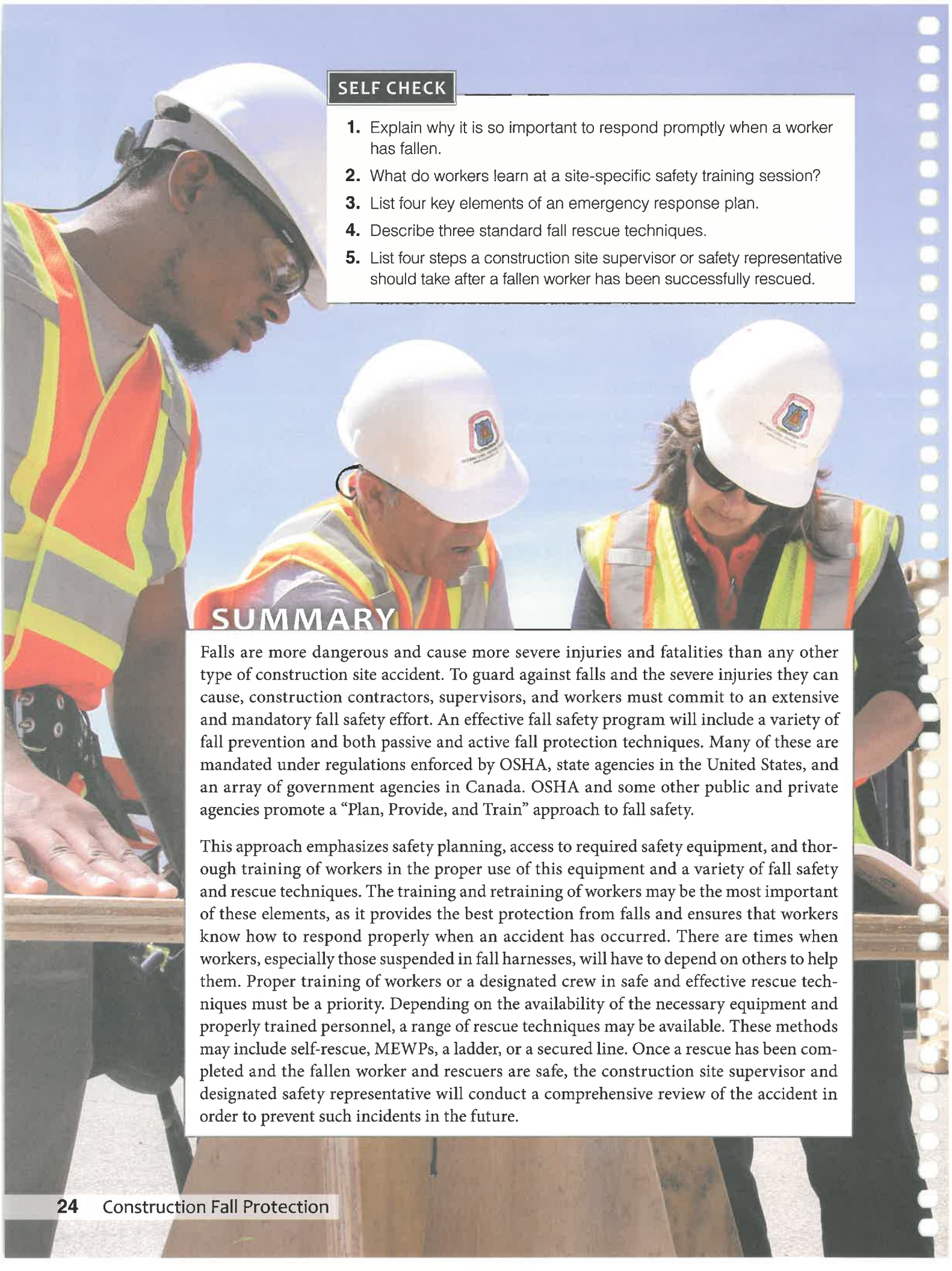
What happens after a rescue has been completed and the fallen worker reaches safety is almost as important as the rescue operation itself. For instance, it is essential for workers who were not affected by the accident or who were not involved in rescue operations to remain in designated safe zones until the site supervisor has notified them otherwise. This will avoid confusion, congestion, and unnecessary exposure to new or existing hazards.

After an accident has occurred and a rescue has been performed, the site supervisor and health and safety representative will usually follow a set procedure. Among their priorities will be the initiation of a thorough investigation of the accident and its likely causes. They may also implement any of the following protocols:

- secure the site of the accident; this is an especially important step in cases involving serious injuries or fatalities
- quarantine all fall-arrest equipment that may have been subjected to fall fatigue or shock loading
- evaluate jobsite-specific rescue and evacuation plans to determine whether they were followed
- document relevant communications with fire, police, and other contractors
- document relevant statements from witnesses and affected workers
- save all photographs of the incident
- record all key information such as dates, time, weather, general site conditions, and specific accident locations

FIGURE 18
MEWP rescue

FIGURE 19
Ladder rescue



SELF CHECK

1. Explain why it is so important to respond promptly when a worker has fallen.
2. What do workers learn at a site-specific safety training session?
3. List four key elements of an emergency response plan.
4. Describe three standard fall rescue techniques.
5. List four steps a construction site supervisor or safety representative should take after a fallen worker has been successfully rescued.

SUMMARY

Falls are more dangerous and cause more severe injuries and fatalities than any other type of construction site accident. To guard against falls and the severe injuries they can cause, construction contractors, supervisors, and workers must commit to an extensive and mandatory fall safety effort. An effective fall safety program will include a variety of fall prevention and both passive and active fall protection techniques. Many of these are mandated under regulations enforced by OSHA, state agencies in the United States, and an array of government agencies in Canada. OSHA and some other public and private agencies promote a "Plan, Provide, and Train" approach to fall safety.

This approach emphasizes safety planning, access to required safety equipment, and thorough training of workers in the proper use of this equipment and a variety of fall safety and rescue techniques. The training and retraining of workers may be the most important of these elements, as it provides the best protection from falls and ensures that workers know how to respond properly when an accident has occurred. There are times when workers, especially those suspended in fall harnesses, will have to depend on others to help them. Proper training of workers or a designated crew in safe and effective rescue techniques must be a priority. Depending on the availability of the necessary equipment and properly trained personnel, a range of rescue techniques may be available. These methods may include self-rescue, MEWPs, a ladder, or a secured line. Once a rescue has been completed and the fallen worker and rescuers are safe, the construction site supervisor and designated safety representative will conduct a comprehensive review of the accident in order to prevent such incidents in the future.

Working Safely at Heights

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. Dictionaries define the term "fall" as a sudden, unanticipated descent in space driven by _____.

2. It takes _____ for most people to realize that they are falling.
   a. one-sixth of a second
   b. one-third of a second
   c. one-half of a second
   d. one second

3. The use of safety systems such as guardrails or barriers, or techniques such as the assembly of roof systems on the ground instead of at elevation to eliminate or reduce the likelihood of falls is referred to as _____ _____.

4. A safety system that relies on the individual worker to perform a personal action to prevent falls or protect against fall-related injuries is referred to as _____ _____ _____.

5. A fall safety system that relies on the use of guardrails, fences, or similar static barriers is referred to as _____ _____ _____.

6. A body can fall seven feet in two-thirds of a second, and may already be moving fast enough to cause a severe injury. (True; False)

7. Employers or contractors often develop a(n) _____ _____ _____ that lists the types of fall protection gear that will be needed and where and when it must be used at the construction site.

8. Construction accidents often can be linked to a(n) _____ _____ of some sort, including a task that has been performed improperly or a hazard that has been overlooked.

9. It is essential for workers to avoid _____, especially when work is repetitious.

10. Workers must be productive, but the drive for productivity must never replace care and safety as a jobsite _____.

11. When regulations that apply to a construction site differ, workers should follow the ____.
    a. OSHA regulations
    b. OH&S regulations
    c. least restrictive regulations
    d. most stringent regulations

12. The set of safety rules and regulations applied to federal projects in Canada are established and enforced by _____.
    a. USACE
    b. ANSI
    c. OSHA
    d. OH&S

13. _____ is a private, nonprofit agency founded in 1918, and that administers a voluntary system of industrial and work standards.
    a. USACE
    b. ANSI
    c. OSHA
    d. OH&S

14. The _____ is a United States federal agency under the authority of the Department of Defense and a major United States Army command.
    a. USACE
    b. ANSI
    c. OSHA
    d. OH&S

15. The employer's responsibility in matters of safety is not just a legal concern, but a _____ one as well.

16. _____ is a three-step approach to fall safety and has been featured in an OSHA fall safety awareness campaign.
    a. Plan, Provide, and Train
    b. Observe, Report, and Correct
    c. Train, Evaluate, and Retrain
    d. Learn, Apply, and Verify

17. A _____ is an individual capable of identifying existing or predictable hazards in working conditions or surroundings and who has been given authority to take corrective measures.
    a. qualified person
    b. foreman
    c. site supervisor
    d. competent person

18. A _____ is an individual who, by possession of recognized degrees, certificates, or professional standing; or by extensive knowledge, training, and experience; has demonstrated the ability to resolve safety issues or solve other work-related problems.
    a. qualified person
    b. foreman
    c. site supervisor
    d. competent person

19. It is important to secure the site of an accident involving serious injuries or fatalities. (True; False)

20. The success of rescues depends not only on the courage and determination of those who carry them out, but also on proper training and the existence of a well-conceived _____ _____ _____ that outlines fall rescue procedures.

21. When workers are suspended in their safety harnesses for long periods, they may suffer from blood pooling in the lower body that can lead to a dangerous condition known as _____ _____.

22. Suspended workers may panic if they are not rescued quickly. (True; False)

23. _____ is the most common method of rescue for a fallen worker who is suspended in a harness.
    a. Self-rescue
    b. Rescue from the floor or area below
    c. Ladder rescue
    d. Mobile elevating work platform rescue

24. What happens after a rescue has been completed and the fallen worker has reached safety is almost as important as the rescue process itself. (True; False)

25. A(n) _____ is a safety system consisting of an anchorage point, connectors, and full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall.
    a. FALS
    b. PFAS
    c. PRTC
    d. OFPS

WORKSHEET 1

Matching Terms

Instructions Match the term with the correct definition.

_____ **1.** Qualified person

_____ **2.** Passive fall protection

_____ **3.** Fall protection

_____ **4.** Competent person

_____ **5.** Active fall protection

_____ **6.** Fall prevention

_____ **7.** Personal fall arrest system (PFAS)

_____ **8.** Leading edge

A. Safety system consisting of an anchorage point, connectors, and full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall

B. Safety system that relies on the individual worker to perform a personal action to prevent falls or protect against fall-related injuries

C. Use of safety systems, such as guardrails or barriers, or techniques, such as the assembly of roof systems on the ground instead of at elevation, to eliminate or reduce the likelihood of falls

D. Individual who, by possession of recognized degrees, certificates, or professional standing; or by extensive knowledge, training, and experience; has demonstrated the ability to resolve safety issues or solve other work-related problems

E. Fall safety system relying on the use of guardrails, fences, or similar static barriers

F. Use of controls such as fall restraints or arrest systems designed to prevent falls or to protect against injury in the event of a fall

G. Individual capable of identifying existing or predictable hazards in working conditions or surroundings and who has been given the authority to take corrective measures

H. Unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surface, such as a deck, that changes location as additional floor or roof decking of formwork sections are placed, formed, or constructed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CHAPTER

2 Controlling and Eliminating Fall Hazards

INTRODUCTION

Hazards are almost always present on construction sites, and not all of them will be readily obvious. Fall hazards may be particularly difficult to identify and easy to overlook because they are so common. Previously unrecognized fall hazards may be the most dangerous kind because they are unexpected and can often be linked to serious accidents and severe injuries. For all of these reasons, a comprehensive effort must be made to identify and assess existing fall hazards and other dangers likely to be created as the project progresses. Once these hazards have been recognized, it will be much easier to eliminate them or sharply reduce the likelihood that they will lead to accidents or injuries. This chapter explains how fall hazards are identified, assessed, and eliminated and controlled. It also outlines the Hierarchy of Fall Protection that lists various methods of fall protection in order according to their effectiveness and the amount of protection they provide.

CONTENTS

OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. Explain the Hierarchy of Fall Protection and why it is important.
2. Explain the relationship between the frequency and duration of exposure to fall hazards and the likelihood of accidents and injuries.
3. List and describe four factors that determine the severity of fall-related injuries.
4. Explain why prompt and effective action is essential once a fall hazard has been identified.
5. Describe the hazard assessment process.
6. Demonstrate the ability to assess fall hazards using a Fall Prevention and Protection Hazard Checklist.

KEY TERMS

Key Terms are in order of appearance.

hazard elimination process of removing jobsite hazards

passive fall protection fall safety system that relies on the use of guardrails, fences, or similar static barriers

personal fall restraint system consisting of an anchorage, full-body harness, and connecting device that prevents a worker from reaching an unprotected edge, thereby preventing a fall; also known as a travel restraint system

positioning device body harness system that allows a worker to work hands-free and to be supported on an elevated vertical surface

fall arrest system form of fall protection designed to safely slow and stop a person who has already fallen

administrative controls for fall protection work practices or procedures that signal or warn a worker to avoid approaching a fall hazard such as a controlled access zone (CAZ) or warning line system

unsafe conditions improperly controlled physical, mechanical, or environmental situations or factors that may expose workers to an increased risk

1 Hierarchy of Fall Protection

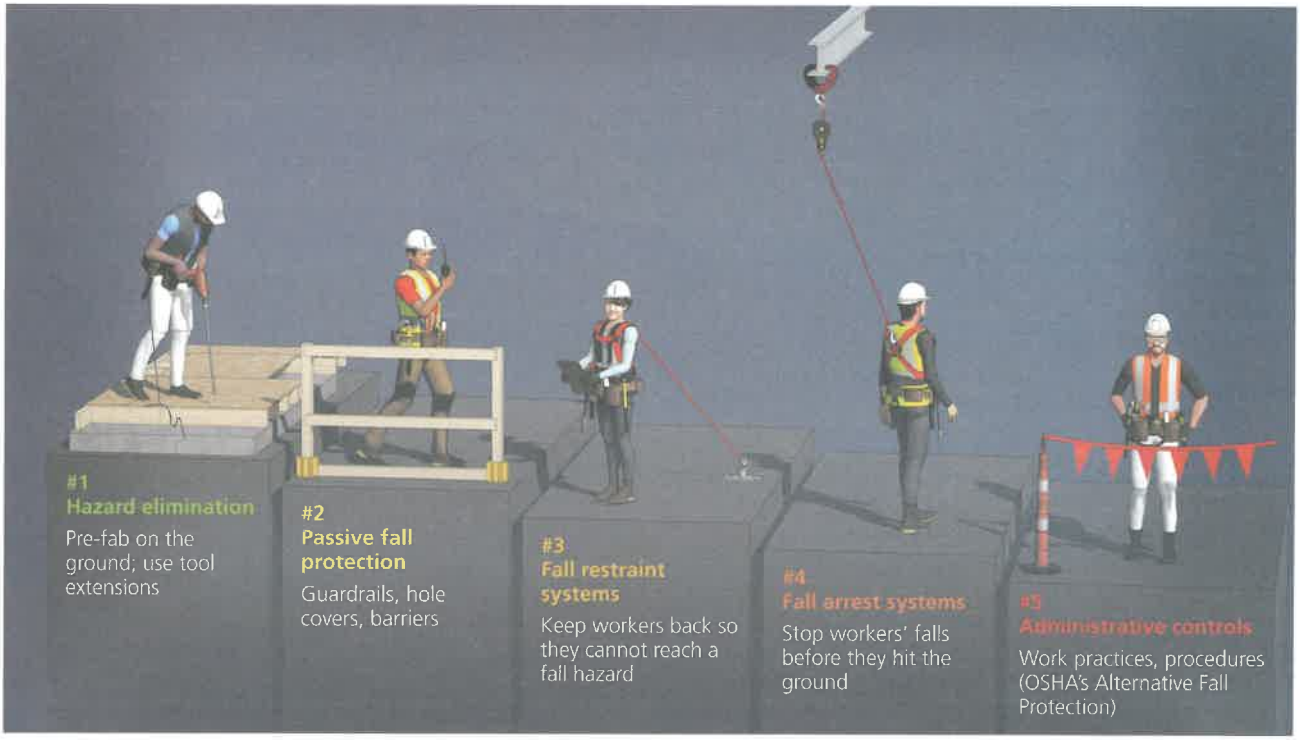
It is the duty of every contractor or other employer to protect workers from falls. Workers themselves share in this responsibility, as does everyone involved in a project and anyone who visits a construction site for any reason. The methods chosen for fall protection must be effective, appropriate for the work site, and suitable for those who will use and be protected by them.

The goal of any fall protection method is to prevent falls and fall-related injuries in a reliable manner. However, not all methods of fall protection are equally safe and efficient. One method may be preferred over another because it offers greater protection, requires less training or action on the part of protected personnel, or is more cost-effective. For instance, methods that will prevent falls are preferable to those that will keep fallen workers from striking the ground but will not keep them from falling in the first place.

Construction industry safety experts, the Occupational Safety and Health Administration (OSHA), and other public and private agencies in the United States and Canada have developed a Hierarchy of Fall Protection. See Figure 1. This hierarchy lists common fall prevention and protection methods in order from most to least effective. The following methods of control comprise the Hierarchy of Fall Protection:

- Hazard Elimination
- Passive Fall Protection
- Fall Restraint
- Fall Arrest
- Administrative Control

FIGURE 1
Hierarchy of Fall Protection



Hazard Elimination

The first and most effective level in the Hierarchy of Fall Protection is hazard elimination, because a fall that never happens will not injure a worker. **Hazard elimination** is the process of completely removing hazards from a jobsite. Once the hazard has been removed, it will no longer present a threat, which makes this method totally effective. However, this method cannot be used in every situation. In most cases, hazard elimination is most easily and effectively implemented with new construction, but is less likely to be cost-effective or practical when working with existing structures. Figure 2 shows framing of a roof section on the ground as one example of hazard elimination.

FIGURE 2
Framing a roof section

Passive Fall Protection

The second level found on the Hierarchy of Fall Protection requires the use of **passive fall protection**—a fall safety system relying on the use of guardrails,

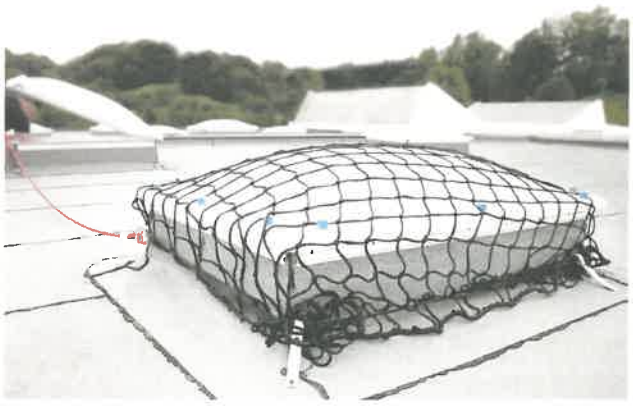
FIGURE 3
Guardrail

fences, or similar static barriers. A guardrail is shown in Figure 3 and a safety fence is shown in Figure 4. A passive fall protection system does not move, adapt, or change when in or out of use. Passive systems do not require the active participation of the worker or the use of personal protective equipment (PPE). Other examples of passive fall protection are hole covers, shown in Figure 5, and safety nets, shown in Figure 6. Safety nets should be installed as close as possible to the walking or working surface. One considerable advantage of passive fall protection is that a single, correctly installed system, such as a fence, can protect hundreds of individual workers or site visitors throughout the workday and even afterwards. This makes passive fall protection extremely cost-effective.

FIGURE 4
Safety fence

FIGURE 5
Hole covers

Netted hole cover



Job-built hole cover

FIGURE 6
Safety nets

Fall Restraint Systems

Level three in the Hierarchy of Fall Protection is fall restraint systems, which are fall protection systems that allow workers the access required to complete a task while preventing them from reaching a point where a fall can occur. A **personal fall restraint**, also known as a travel restraint, is a system consisting of an anchorage, full-body harness, and connecting device that prevents a worker from reaching an unprotected edge, thereby preventing a fall. A fall restraint will allow a worker to travel just far enough to reach the edge, but not far enough to fall over. Although fall restraints may limit a worker's mobility, the advantage is that it will eliminate free fall and any secondary injuries associated with the fall. Figure 7 shows a personal fall restraint in use. A **positioning device** is a personal fall protection system that allows workers to work hands-free. Positioning devices can be used for concrete formwork walls, reinforcing rebar walls, and columns. Figure 8 shows a positioning device being used on a concrete form wall.

FIGURE 7
Personal fall restraint

FIGURE 8
Positioning device

FIGURE 9
Fall arrest system

Fall Arrest Systems

Frequently used when working at heights, a **fall arrest system** is intended to safely slow and stop a worker who has already fallen. When properly used, these systems can help prevent the severe injuries often associated with falls. It is important to remember that the fall arrest system is designed to stop a fall once it has happened, not prevent the fall in the first place. Fall arrest systems consist of an anchorage, full-body harness, and connecting device. See Figure 9.

Administrative Controls

Administrative controls for fall protection consist of work practices or procedures that signal or warn a worker to avoid approaching a fall hazard, and are considered to be the least reliable and effective means of fall protection. Such methods may include controlled access zones (CAZs) or warning line systems, as shown in Figure 10. Administrative controls are intended to change the behavior of workers rather than remove hazards or provide PPE. Administrative controls should never be used without a written fall protection plan, and they should only be considered when more effective fall protection methods are not feasible or would create a greater hazard.

FIGURE 10
Warning line system

SELF CHECK

1. What is the Hierarchy of Fall Protection?
2. Why is hazard elimination considered to be the preferred and most effective form of fall protection?
3. Describe various types of passive fall protection and explain how they help guard against falls and fall-related injuries.
4. Define administrative controls and describe how they are typically used to protect workers from falls.

2 Fall Hazard Recognition

Fall hazards must be identified before they cause an accident. Most falls and fall-related injuries and fatalities can be prevented if fall hazards are identified and eliminated or sufficiently controlled in a timely manner. Figure 11 shows several examples of fall hazards that may commonly be found on construction sites.

Unprotected stairwell

Poor housekeeping

Unprotected leading edge

FIGURE 11
Construction site fall hazards

What Is a Fall Hazard?

A fall hazard is anything that might cause a person to fall. This may include obstacles or situations that may cause people to trip, stumble, or lose their balance. It may also include the potential loss of the physical support required to prevent a fall, such as when flooring or work platforms collapse. Other examples of fall hazards include the following:

- walking near an unprotected leading edge and tripping over a protruding board
- slipping while climbing an icy stairway
- stepping into a skylight opening while carrying a sheet of plywood on a flat roof
- collapse of an overloaded scaffold

Unsafe Conditions

Often fall hazards in the workplace are due to **unsafe conditions**, which are improperly controlled physical, mechanical, or environmental situations or factors that may expose workers to an increased risk of falling. The unsafe conditions that can cause falls and fall-related injuries include work surfaces that are not strong enough to support the weight of workers and their tools and materials. Safety regulations in the United States and Canada require contractors and other employers to provide safe workplaces and working conditions that are free of such hazards. An example of obviously unsafe conditions is shown in Figure 12.

FIGURE 12
Unsafe conditions

Fall Hazard Exposure

Fall hazard exposure occurs any time that a worker is threatened by a hazard and may fall because of it. For instance, workers are exposed to a fall hazard when approaching an unprotected edge, such as the end or side of a scaffold platform that does not have the proper guardrails. UBC members are exposed to fall hazards when work is performed on slippery or uneven surfaces. Common examples of fall hazard exposure and the fall prevention or fall protection practices that may be used to minimize them are shown in Table 1.

TABLE 1 *Fall hazard exposure*

Basic job steps	Potential hazards	Protection or prevention
Entrance into or exit from building	Trips, slips, and falls on piles of scrap or building materials, holes in the ground, excavations	Review site with the general contractor before setup to ensure no hazards are created for workers
	Tools, materials falling from workers overhead	Hard hats will be required at all jobsite locations
Metal stud framing Drywall Interior Systems	Fall hazards	Proper PPE for 100% fall protections Housekeeping
	Overhead hazards	Proper PPE Certified lift operators
Any work inside the building prior to completion of windows and/or stairs	Falls from window openings and through floor openings	Review site with the general contractor to ensure all openings have been guarded or barricades erected
Working above floor level	Falling from elevation	Proper PPE is to be worn Scaffolding will be set up per manufacturer's instructions A competent person, trained and evaluated in scaffold setup, will direct setup All planks will be inspected prior to use All scaffolding will be inspected prior to each shift
	Falling from ladders	Ladder use will be addressed in the initial crew safety meeting All workers will be trained on safe ladder use Minimum type 1A stepladders will be used
	Falling off unprotected stairs	Standard guardrail will be installed on at least one side of the stairs with 4 or more risers
	Tripping/falling while using stilts	Stilts brought to the jobsite must be inspected by the employer prior to use
Metal framing scaffold stairwells	Falling from height of 10′-0″ or more	Welded frame scaffolding with appropriate guardrails will be set up by a trained and qualified erector

How Likely Are Fall Hazards to Cause an Accident?

On a jobsite, a fall-related accident or injury becomes almost inevitable when workers are exposed to an uncontrolled fall hazard over an extended period of time. However, any exposure to a fall hazard, no matter how brief, carries some risk of a fall.

Frequency, Duration, and Scope of Exposure The likelihood of a fall depends primarily on three factors: frequency, duration, and scope of exposure to the hazard. Each time a worker is exposed to a fall hazard, there is a chance that the worker will fall. The risk is cumulative and will become greater as the frequency of exposure increases. A worker may be exposed to a fall risk for a short time or for a much longer period of time. The longer a worker is exposed to a fall hazard, the greater the likelihood that a fall will occur. A fall hazard may place only one worker at risk, or may pose a threat to several workers. In addition, there may be more than one such hazard. The chance of a fall increases as the number of workers exposed to a hazard increases. In addition, the greater the number of hazards on the jobsite, the greater the possibility of an accidental fall taking place.

How Likely Are Falls to Cause Severe Injuries?

Construction site falls often lead to serious or even fatal injuries, especially if nothing has been done to protect the worker from the physical harm that a fall may cause. Almost one-third of all construction site fatalities—about 34 percent—can be attributed to falls. Falls also cause fractures, concussions, and many other types of injury that may require medical treatment or hospitalization and can either temporarily or permanently disable a worker. The severity of fall-related injuries is dependent upon a variety of factors.

Distance and Speed of the Fall Once people or objects enter free fall, they will accelerate until reaching a velocity of approximately 120 miles per hour (mph). This is referred to as *terminal velocity*, the fastest speed that a falling object or person will attain during a fall. Terminal also hints at the frightening truth about free falls: the fact that hitting the ground or the water at such a high speed will almost certainly result in death. A falling construction worker is unlikely to fall far enough to reach terminal velocity; even so, life-threatening speeds can be reached in just a few feet of free fall.

Speed of Deceleration The sudden stop at the end of a fall is what will cause injury or death. The faster a falling person decelerates, the greater the likelihood of serious injury or death. This is because a rapid or instantaneous deceleration will exert tremendous forces on the body.

Nature of the Surface It is a known fact that a fall into water will be much less likely to cause harm than a fall onto rock. Relatively soft surfaces

may reduce the rate of deceleration just enough to prevent severe injury or death. For example, a fall onto soft turf will be less likely to cause an injury than a fall onto concrete.

Orientation of the Body at Impact Whether or not a fall causes serious injuries may depend on luck. Passengers have fallen out of airplanes and survived, while other people have been killed by a fall of just a few feet. This is true, in part, because the severity of fall-related injuries is often determined by the orientation of the body at the moment of impact. It is generally known that landing on the head after a fall is more dangerous than landing on the feet. During a fall there will usually not be time to shift body position, and as a result luck will play an important role when it comes to the orientation of the body upon impact.

SELF CHECK

1. What is a fall hazard?
2. How can most falls and fall-related injuries and fatalities best be avoided?
3. Describe fall hazard exposure.
4. Explain how the frequency of exposure influences the likelihood of falls and fall-related injuries.
5. What effect does body position at the moment of impact have on the severity of a fallen worker's injuries?

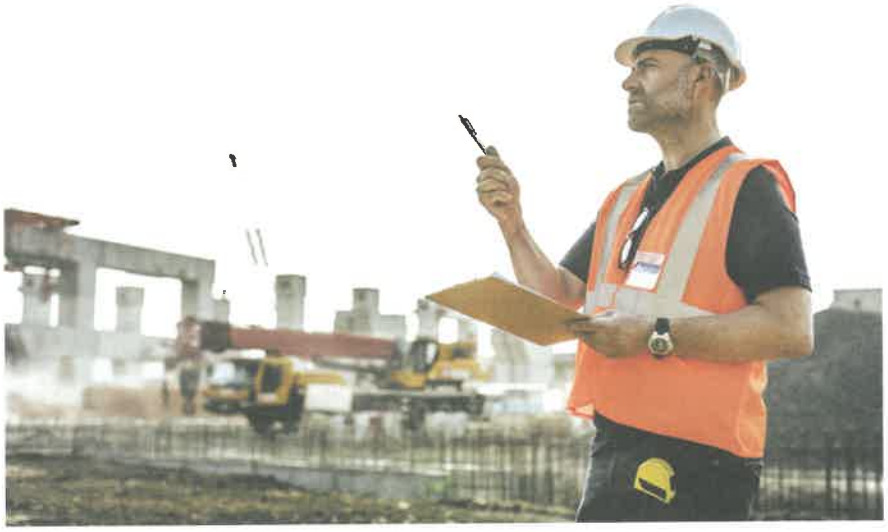
3 Fall Hazard Assessment

A worker's health, life, or livelihood should never be trusted to luck. However, anytime that work is performed on a jobsite where fall hazards have not been adequately controlled, that just may be the case. Controlling fall hazards will typically require the use of one or more of the methods found in the Hierarchy of Fall Protection—fall hazard elimination, passive fall protection, fall restraint, fall arrest, and administrative controls. However, it will be difficult to eliminate fall hazards or protect workers unless these hazards have been properly assessed.

What Is a Fall Hazard Assessment?

A fall hazard assessment is used to evaluate a workplace or work situation to determine how vulnerable workers on the jobsite may be to falls. The assessment may consist of a simple checklist or can involve a thorough investigation of the construction site and work area. Fall hazard assessments on a construction site can be especially challenging because the conditions are

FIGURE 13
Conducting a fall hazard assessment



constantly changing. Figure 13 shows an inspector conducting a construction site fall hazard assessment.

Importance of Continuing Assessment

Fall hazard assessments should be completed and updated each day, even though it may appear as if little has changed in the work area. Assessments are completed daily to avoid becoming complacent. It is very easy for workers to get so accustomed to their regular tasks and the area surrounding them that they become careless and unaware of hazards. Daily hazard assessments will help fight complacency by reminding workers of hazards and strengthening awareness. Fall hazard controls should be situational rather than static, and daily assessments will make it easier for workers to match safety measures to constantly changing tasks, environments, and hazards.

Responsibility for Fall Hazard Assessment

A competent person may be placed in charge of jobsite fall hazard assessment, but identification of hazards will be the responsibility of everyone involved in the project, including each worker on the construction site. Workers should learn about hazard identification and control in order to have more control over their own safety. Workers should feel free to openly discuss any fall hazard or unsafe work practices that they may observe on the jobsite. Figure 14 shows construction site workers pointing out a hazard.

Process of Assessing Hazards

The assessment process will begin before any work is done at the work site and should continue throughout the project. This means that the site must be thoroughly inspected for fall hazards and other threats to worker safety.

FIGURE 14
Pointing out a hazard

The inspection should consider both existing fall hazards and others likely to be encountered or created as the project progresses.

The best tools that can be used when identifying fall hazards are the knowledge and experience of the competent person and all workers. Familiarity with the work site and the project is important, and paying attention to detail and asking questions is always helpful. The following are examples of hazards or potential trouble spots that all workers should watch for and consider:

- holes in walkways or other surfaces through which workers could step or fall
- elevated walkways or other surfaces 6′-0″ or more above a lower level
- skylights and smoke domes through which workers could step or fall
- wall openings such as windows or doors through which workers could fall
- trenches and other excavations
- any surfaces from which workers could fall onto dangerous equipment
- hoist areas where guardrails have been removed to receive materials
- sides and edges of established floors, mezzanines, balconies, and walkways that are 6′-0″ or more above a lower level and are not protected by guardrails at least 39″ high
- ramps and runways that are not protected by guardrails at least 39″ high
- leading edges of floors, roofs, and decks that change location as additional sections are added
- wells, pits, or shafts not protected with guardrails, fences, barricades, or covers

Authorized personnel must ask the right questions when attempting to identify fall hazards and other safety concerns. Questions that might be asked include the following:

- Will workers be using portable ladders, supported scaffolds, mobile elevating work platforms (MEWPs), or suspension platforms to reach their work areas?
- How and where will this equipment be used?
- Will this equipment be used on rough ground or other uneven surfaces?
- Will workers be exposed to overhead power lines?
- Will work be done in unusually hot, cold, or windy conditions?
- Will workers need to frequently lift, bend, or move in ways that might put them off balance?
- Will work be done in extended shifts, which could contribute to fatigue?

Taking Prompt and Effective Action

Once hazards have been identified, ways to effectively eliminate or control them must be determined. It would be useless to identify a hazard if action is not taken to guard against it. A properly conducted inspection should provide the competent person with the information required to identify all existing or potential fall hazards. Awareness of these hazards on the part of workers, supervisors, and everyone involved in a project is essential. The following scenario illustrates what can happen when workers and others are unaware of a threat posed by a fall hazard.

FALL AWARENESS SCENARIO

Three workers, including a millwright, met on the third level of a building to discuss pipework installation. After they had talked, the three began to walk north on the third level on their way back to the floor level. However, the millwright stopped and returned to the area where the meeting had been held. As the other two continued onward to the ground level, they heard the emergency horn sound, and as they headed out of the building, they noticed the millwright lying on the floor. Paramedics were called immediately, but by the time they arrived the millwright was dead. It was later determined that the millwright had fallen through an unmarked opening, 5′-0″ in diameter, and struck a MEWP located on the ground floor.

- How could this incident have been prevented?
- Have you ever known anyone who has fallen through an upper-level opening?

Inspection Checklists

Inspection checklists can be useful when conducting inspections because they will provide guidance in identifying hazards. They can be particularly

helpful when authorized personnel are unfamiliar with the hazards in the workplace. A checklist can prove useful as a reminder as well. Figure 15 shows an example of a fall hazard checklist used to assess jobsite hazards. Checklists are tools and will only be useful if action is taken to resolve the

FIGURE 15
Sample fall hazard checklist
(continued on next page)

FALL PREVENTION AND PROTECTION HAZARD CHECKLIST

Building:	Location:	Assessment Date:

Related operating procedures reviewed	Yes	No
Location marked and entry controlled	Yes	No

FALL HAZARD CHECKLIST

Can an employee enter the area without restriction and perform work?	Yes	No
Are fall prevention and protection systems such as guardrails, toeboards, hole covers, and barriers in place?	Yes	No
Have slipping and tripping hazards been removed or controlled?	Yes	No
Have visual warnings of fall hazards been installed?	Yes	No
Can the distance a worker could fall be reduced by installing platforms, nets, etc.?	Yes	No
Are any permanently installed floor coverings, gratings, hatches, or doors missing?	Yes	No
Does the location contain any other recognized safety and/or health hazards?	Yes	No
Is the space designated as a Permit Required Confined Space?	Yes	No
Have anchor points been designated, tested, and inspected?	Yes	No
Are load capacities marked on elevated work platforms?	Yes	No
Are permanent ladders or stairs used to access elevated locations?	Yes	No
Is housekeeping adequate to prevent slips and falls?	Yes	No
Are there any excavations that need to be barricaded off?	Yes	No
Are there any unprotected sides or edges where a worker could fall 6 feet or more?	Yes	No
Is there a rescue plan in place?	Yes	No

ASSESSMENT INFORMATION: (indicates specifics with initials)

Initials	Hazard	Remarks/Recommendations
	Total potential fall distance:	
	Number of workers involved:	
	Frequency of task:	
	Obtainable anchor point strength:	
	Required anchor point strength:	

FIGURE 15 (CONTINUED)

Sample fall hazard checklist

ADDITIONAL REQUIREMENTS:

Potential environmental conditions that could impact safety:

Initials	Condition	Remarks/Recommendations

Possible required structural alterations:

Initials	Alteration	Remarks/Recommendations

Possible task modification that may be required:

Initials	Task	Remarks/Recommendations

Breakdown of vertical and horizontal movement: (sketch out work task):

Training requirements:

Initials	Requirement	Remarks/Recommendations

Personal protective equipment required:

Initials	Requirement	Remarks/Recommendations

AUTHORIZATION

Approved

I certify that I have conducted the Fall Protection Hazard Assessment Plan of the above designated location and have detailed the findings of the assessment on this form.

Further detailed on this attachment: Yes No

Name:	Signature:	
Title:	Date:	Time:

ASSESSMENT FORM RETENTION INFORMATION	ATTACHMENTS	
Permanent Retention File:	Location:	*Yes No

Date Filed:	Filed By:	*See Following Pages

Approved by Company Safety Officer:

Name:	Date:

problems they might reveal. Such checklists are often not site-specific and may not support a comprehensive inspection. In addition, the use of checklists can become routine, which could lead to dangerous complacency. The following procedure explains the process of how to conduct a hazard inspection.

PROCEDURE

How to Conduct a Hazard Inspection

1. Walk the jobsite or specific work location during each shift and look for hazards.
2. Identify the potential hazards that may become evident on that work shift.
3. Complete a Fall Prevention and Protection Hazard Checklist with the hazards identified in step 2, including recommended actions to be made.
4. Give the list of hazards to the competent person.
5. Take the corrective action recommended by the competent person.

SELF CHECK

1. What is a fall hazard assessment?
2. Give four examples of likely hazards or potential trouble areas that should catch the attention of work-site personnel or the competent person.
3. List four questions that fall hazard authorized personnel might ask during a hazard assessment.
4. Who is responsible for identifying fall hazards on a work site?
5. Describe a typical inspection checklist.

SUMMARY

Construction site fall hazards are very common and can be easily overlooked. They can be extremely dangerous and exposure to them may lead to serious accidents and severe or even fatal injuries. To protect workers, safety experts and government agencies such as OSHA have developed a Hierarchy of Fall Protection. Listed in order of preference and likely effectiveness, the hierarchy includes hazard elimination, passive fall protection, fall restraint systems, fall arrest systems, and administrative controls. However, the effective use of any of these approaches depends on correctly identifying existing or potential fall hazards and properly assessing the threat that they represent. This will require an understanding of fall exposure and how that influences the possibility of a worker falling and the likelihood that the fall will cause a severe or fatal injury. The chance that an uncontrolled fall hazard will cause an accident is typically proportional to the number of hazards and the number of workers exposed to them, as well as the frequency and duration of the exposure.

The severity of a fallen worker's injuries may be determined by the speed and distance of the fall, the rate of deceleration, the nature of any surface the falling worker strikes, and the worker's body position upon impact. To protect workers, it is critical that comprehensive assessments of fall hazards be performed. Assessments should be done at the beginning of a project and on a regular basis throughout the day as work progresses. Personnel who conduct work-site assessments should have an abundance of industry and site-specific experience and must ask critical questions concerning the exposure of workers to likely hazards. Sometimes checklists are used to streamline the hazard assessment process. However, the checklists are usually not site-specific and can cause supervisors or workers using them to grow complacent. The information gathered when filling out a checklist will only be useful if prompt and effective action is taken to eliminate or control the hazards revealed.

Controlling and Eliminating Fall Hazards

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. In the Hierarchy of Fall Protection, ____ refer(s) to a fall safety system relying on the use of guardrails, fences, or similar static barriers.
   a. hazard elimination
   b. fall restraint
   c. passive fall protection
   d. administrative controls

2. In the Hierarchy of Fall Protection, ____ refer(s) to work practices or procedures that signal or warn a worker to avoid approaching a fall hazard.
   a. hazard elimination
   b. fall restraint
   c. passive fall protection
   d. administrative controls

3. ____ is a personal fall protection system that allows personnel to work hands-free.
   a. Hazard elimination
   b. A positioning device
   c. Passive fall protection
   d. A fall restraint system

4. Fall hazards in the workplace are often due to _____ _____, which are improperly controlled physical, mechanical, or environmental situations or factors that may expose workers to an increased risk of falling.

5. The potential loss of the physical support required to prevent a fall, such as when flooring or a work platform collapses, is one common type of _____ _____.

6. Administrative controls are intended to change worker behavior rather than removing the actual hazard or providing PPE. (True; False)

7. Fall _____ allows workers the access required to complete a task while preventing them from reaching a point where a fall can occur.

8. The number of hazards of a given type and the number of workers exposed to a given hazard are both measures of ____.
   a. scope of hazard exposure
   b. duration of hazard exposure
   c. intensity of hazard exposure
   d. frequency of hazard exposure

9. The chance that a worker will fall is cumulative and grows as the _____ increases.
   a. scope of hazard exposure
   b. severity of hazard exposure
   c. intensity of hazard exposure
   d. frequency of hazard exposure

10. The terminal velocity of a falling object or person is about _____.
   a. 80 mph
   b. 120 mph
   c. 150 mph
   d. 170 mph

11. Life-threatening speeds can be reached in just a few feet of free fall. (True; False)

12. People have fallen out of airplanes and survived while others have been killed by a fall of just a few feet; this is true, in part, because the severity of fall-related injuries is often determined by the _____ of the body upon impact.

13. A fall hazard assessment is a(n) _____ of a workplace or work situation intended to determine the vulnerability of workers to falls.

14. Fall hazard assessments should be completed and updated every day, even if little appears to have changed in the work area. (True; False)

15. The task of identifying work-site fall hazards is the responsibility of _____.
   a. the property owner
   b. OSHA inspectors
   c. the safety expert
   d. everyone at the work site

16. Authorized personnel must ask the _____ _____ when attempting to identify fall hazards and other safety concerns.

17. Filling out checklists can become routine, which could lead to dangerous _____.

18. Inspection checklists can be particularly useful for conducting fall hazard assessments because they provide _____ in identifying hazards.

19. One fall protection method may be preferred over another because it offers greater protection, requires less training or action on the part of protected personnel, or is more _____-_____.

20. Which of the following control methods listed on the Hierarchy of Fall Protection is preferred?
   a. administrative controls
   b. fall restraint
   c. passive fall protection
   d. hazard elimination

21. A fall-related accident or injury becomes almost _____ when workers are exposed to an uncontrolled fall hazard over an extended period of time.

22. _____ refer(s) to fall protection systems that allow workers the access required to complete a task while preventing them from reaching a point where a fall can occur.
    a. Administrative controls
    b. Fall restraint
    c. Passive fall protection
    d. Hazard elimination

23. Fall hazard controls should be _____ rather than static, and daily assessments make it easier for workers to match safety measures to constantly changing tasks, environments, and fall hazards.

24. Falling on soft turf is just as likely to cause a severe injury as falling onto concrete. (True; False)

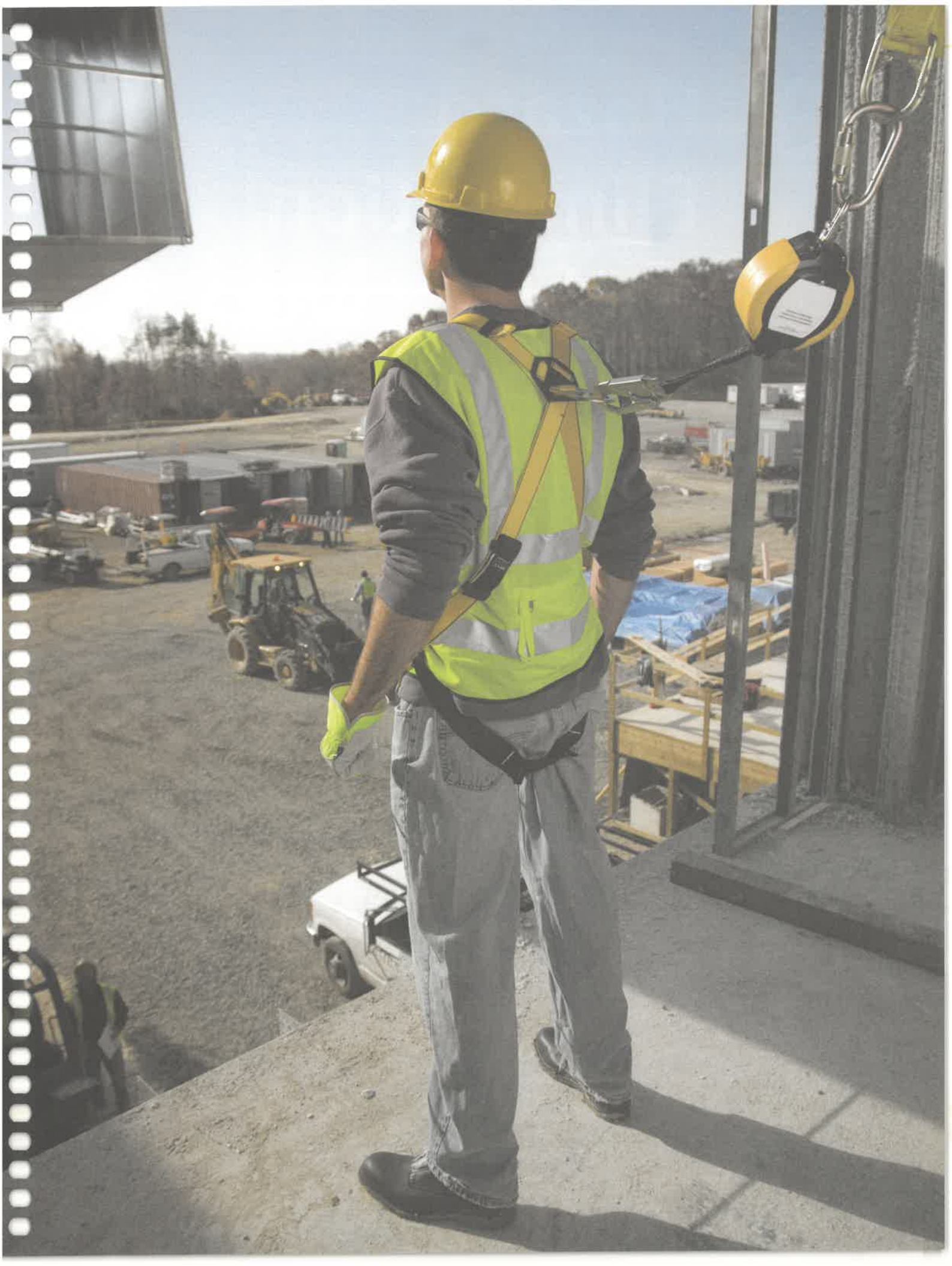
25. It is difficult, if not impossible, to eliminate fall hazards or protect workers from fall-related injuries unless construction site fall hazards have been properly _____.

WORKSHEET 1

Hierarchy of Fall Protection

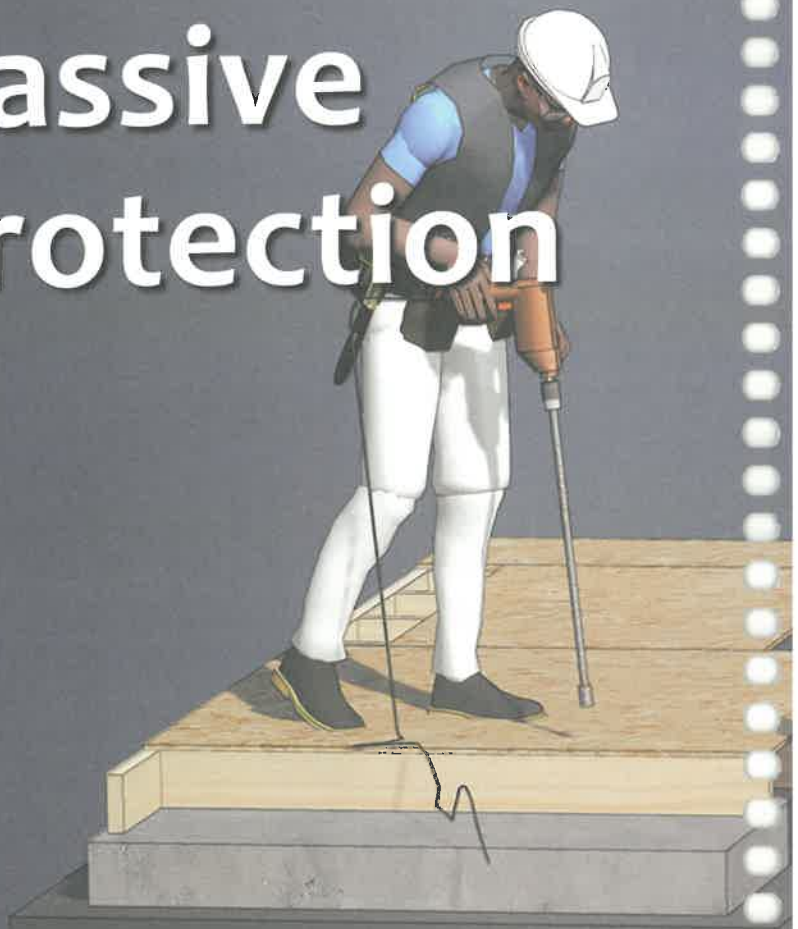
Instructions: Using the Controls list below, fill in the blanks below the workers in the image with the appropriate control. On the next blank line below the workers, from the Description list, place the appropriate letter matching the description of the control.

Controls	Descriptions
Fall arrest systems	A: Guardrails, hole covers, barriers
Administrative controls	B: Stop workers falls before they hit the ground
Fall restraint systems	C: Pre-fab on the ground; use tool extensions
Hazard elimination	D: Work practices, procedures (OHSA's Alternative Fall Protection)
Passive fall protection	E: Keep workers back so they cannot reach a fall hazard



CHAPTER

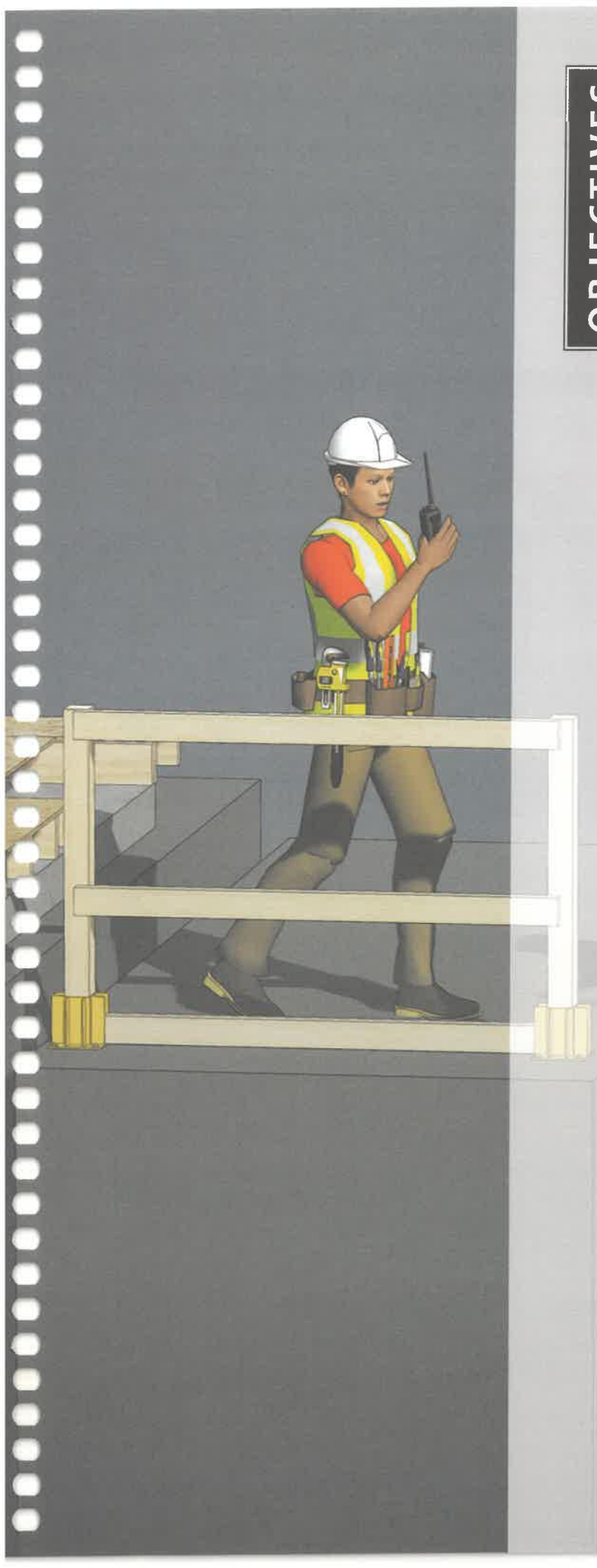
3 Hazard Elimination and Passive Fall Protection



INTRODUCTION

Falls rank among the most common jobsite accidents and are a leading cause of severe, work-related injuries and fatalities. Most construction sites contain many fall hazards, some obvious and others hidden. This chapter focuses on hazard elimination and passive methods of fall protection, such as good housekeeping in walkways and work areas and the installation and maintenance of guardrails, safety nets, hole covers, and similar passive safety systems.

CONTENTS



OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. Explain why hazard elimination is the most effective way to protect workers from fall-related injuries.
2. List and describe three ways a fall hazard can be eliminated.
3. List and describe three types of passive fall protection.
4. Describe a typical guardrail system and explain how it is installed.
5. Describe two types of safety nets and how they can protect workers.
6. Explain how hole covers are used to protect workers from falls and fall-related injuries.

KEY TERMS

Key Terms are in order of appearance.

guardrail system barriers installed to prevent personnel from falling while working or moving from place to place on elevated walkways or working surfaces

leading edge unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surface such as a deck that changes location as additional floor or roof decking of formwork sections are placed, formed, or constructed

safety net system made from synthetic materials and designed to catch falling debris, a fallen worker, or a combination of both

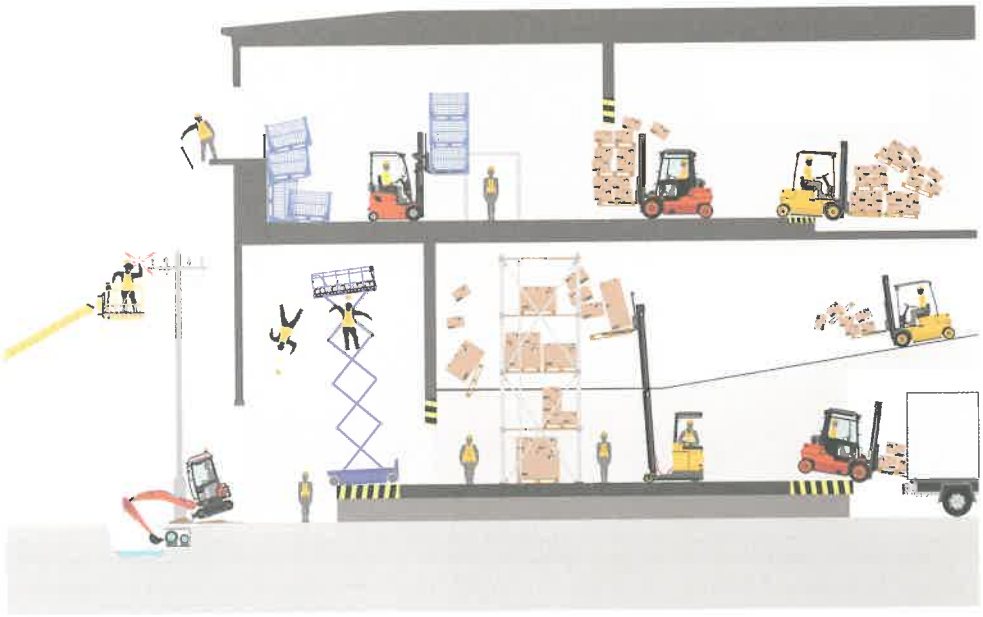
hole cover physical barrier placed over a hole or opening in the working or walking surface that will prevent a person or object from falling through

1 Hazard Elimination

TRADE TIP

Being proactive can eliminate the possibility of a problem occurring in the first place.

Hazard elimination is at the top of the Hierarchy of Fall Protection for the obvious reason that a fall that never happens cannot injure a worker. In the construction industry, fall prevention begins with hazard elimination, which is the complete removal of hazards from a jobsite. Once a hazard has been removed, it will no longer be a threat.



A wide range of methods are available for eliminating hazards and promoting fall safety among construction workers. The safest and most effective of these is the proper identification and elimination of fall hazards at the jobsite. In some cases, it may be possible to eliminate or control fall hazards by changing work procedures, redesigning the working environment, installing hole covers, or building roofs on the ground and lifting them into place.

SAFETY TIP

Learn to recognize and avoid unsafe conditions. Always report hazards immediately so they can be quickly eliminated or controlled.

FALL AWARENESS SCENARIO

Three carpenters were hired to complete a shingling project. Before they began work, the carpenter who had been designated the competent person completed a hazard assessment and a fall protection plan for the location. He then climbed a ladder to reach the second-story roof where he attached his own lifeline to a strap anchor on one side of the building and the lifelines of the other two carpenters to a strap anchor on the opposite side. Once all three workers were on the roof and connected to their lifelines, they prepared to start shingling. While trying to set up equipment, the first carpenter detached his lifeline from the anchor because it had become tangled with an extension cord. Shortly after disconnecting his lifeline, he lost his footing, slid down the roof, and fell off the edge to the ground approximately 22′-0″ below. One of the other carpenters lunged toward the falling worker trying, unsuccessfully, to prevent the fall. The first carpenter fell all the way to the ground while the second was arrested by his fall protection system. He was able to self-rescue by climbing down a ladder. The third carpenter called 911 and then performed CPR on the carpenter who struck the ground. Severely injured, the fallen carpenter was unresponsive to CPR and was later pronounced dead on arrival at the hospital emergency room.

- How could this accident have been prevented?
- Have you ever known anyone who fell after disconnecting from a lifeline?

Eliminate Hazardous Conditions

Slips, trips, and falls can be caused by or associated with hazardous conditions at the jobsite. Oftentimes, construction workers do not consider slips and trips to be "falls," but they are included under the fall category in OSHA and OH&S. These may be caused by unmarked or unprotected openings, cluttered walkways, slippery floors, or almost any circumstance that can make falls more likely. To help prevent falls, the jobsite should be carefully checked for the following dangerous conditions:

- wet or muddy surfaces
- sudden changes in grade
- cluttered walkways or work areas
- unmarked or unprotected holes and other openings

If possible, the hazardous working conditions previously listed should be eliminated or controlled before workers enter the area. Figure 1 shows a dangerous opening in a roof and Figure 2 shows a dangerously cluttered walkway.

FIGURE 1
Opening in a roof

SAFETY TIP

Workers involved in hoisting operations must be familiar with proper rigging and hoisting techniques to prevent accidents and injuries.

FIGURE 2
Cluttered walkway

Minimize Exposure to Fall Hazards

Among the simplest and most effective ways that workers can be protected from falls is by minimizing their exposure to fall hazards. This can often be done through the use of safer construction techniques. For example, it may

FIGURE 3
Framing a roof section

FIGURE 4
Placing the roof section

be possible for structures to be built on the ground or at floor level and then lifted and placed into position. Figure 3 shows workers framing a roof on the ground and Figure 4 shows it being lifted into place with machinery.

Exposure to fall hazards can be reduced through the use of tool extensions that make it possible to perform overhead work from ground level that would otherwise be out of reach. Tool extensions include poles that can be attached to screw guns or other tools for use in overhead applications. Figure 5 shows an example of a tool extension. Figure 6 shows a tool extension being used to fasten ceiling wire to a substrate.

FIGURE 5
Example of a tool extension

FIGURE 6
Fastening ceiling wire using a tool extension

SELF CHECK

1. Why is hazard elimination the most effective and efficient way to protect workers from falls and fall-related injuries?
2. List four dangerous working conditions that should be corrected before workers enter the area.
3. What is a tool extension and how does it help prevent falls?

2 Passive Fall Protection

Passive fall protection consists of physical barriers such as the guardrails placed around unprotected edges, covers placed over holes, and safety nets installed below elevated walkways and work surfaces. These forms of protection are considered passive because they do not require that any action be taken by workers or other personnel in order to benefit from the protection they offer. For example, a properly installed guardrail system will make it far less likely that a worker will step beyond or fall over an elevated edge.

SAFETY TIP

Eliminating a fall hazard is the most effective fall protection strategy.

Guardrail Systems

Guardrail systems are barriers installed to prevent personnel from falling while working or moving from place to place on elevated walkways or working surfaces. A properly installed guardrail system will make it far less likely that a worker will step beyond or fall over an elevated edge. Guardrails are often painted safety yellow so they can be easily seen and serve as a warning to anyone approaching the hazard. Figure 7 shows a typical guardrail system.

SAFETY TIP

For additional safety, a guardrail system should be placed on every platform, regardless of its height.

FIGURE 7
Guardrail system

Guardrails are frequently used to protect elevated walkways, work areas, and leading edges that would otherwise represent significant fall hazards. A guardrail system is one of the most commonly used types of fall protection, and consists of a top rail, midrail, and intermediate vertical members that function as a single unit or barrier to prevent workers from falling. This type of fall protection system is often combined with toeboards that are intended to prevent tools and materials from sliding or rolling over the side of the walkway or work surface and endangering personnel below. A guardrail system with toeboards is shown in Figure 8.

Guardrails of various types and configurations may be used extensively throughout a construction site. Some guardrails, such as those used for certain landings or work platforms, may be permanent and will remain in place for the duration of the project, or even after its completion. Other guardrails, such as those placed around holes or leading edges, are temporary and will be removed or

FIGURE 8
Guardrail system with toeboards

placed elsewhere as work on the project continues. A **leading edge** is an unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surface, such as a deck, that changes location as additional floor or roof decking of formwork sections are placed, formed, or constructed.

Permanent Guardrails If the guardrail is intended to remain in place throughout the project, it can be bolted or welded to steel or even embedded in concrete. Guardrails of this type are sturdier and more durable than temporary guardrail. However, they are difficult to remove, and the materials used to build them often cannot be reused. Figure 9 shows a permanent guardrail.

FIGURE 9
Permanent guardrail

Temporary Guardrails Leading edges and other fall hazards likely to exist for only a short time are typically protected by a temporary guardrail that can be removed and relocated as required. Generally lightweight and easily installed or removed by a single person, temporary guardrails such as the ones shown in Figure 10 will often consist of only a basic rail system. During installation of temporary guardrail systems, the manufacturer's specifications should be checked to ensure that all materials comply with applicable OSHA or OH&S regulations.

FIGURE 10
Temporary guardrail

TRADE TIP

Review and understand the company's job-specific safety requirements. Many times they are more stringent than OSHA or OH&S regulations.

Guardrail Guidelines Since guardrail systems are intended to prevent serious accidents and save lives, they must be correctly built and properly maintained. To make sure they function as intended, guardrails must conform to a wide array of regulations. Workers should make certain that all relevant local, state, federal (OSHA), and provincial (OH&S) regulations

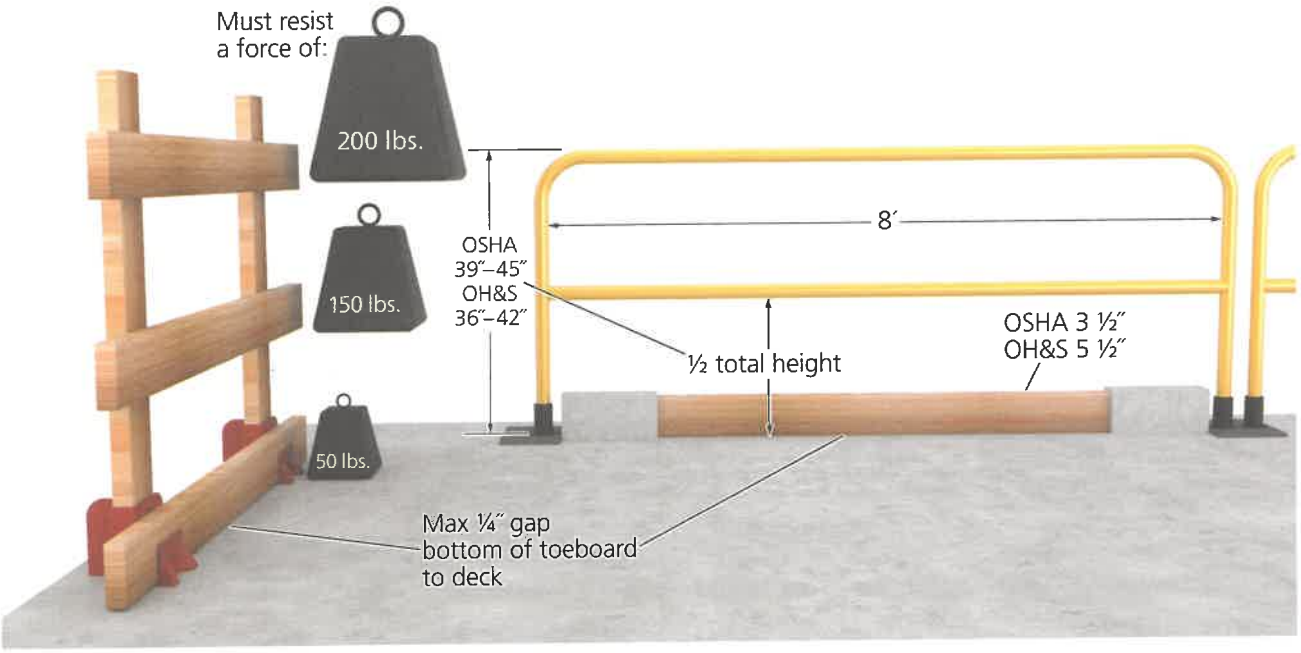


FIGURE 11
Top rail placement

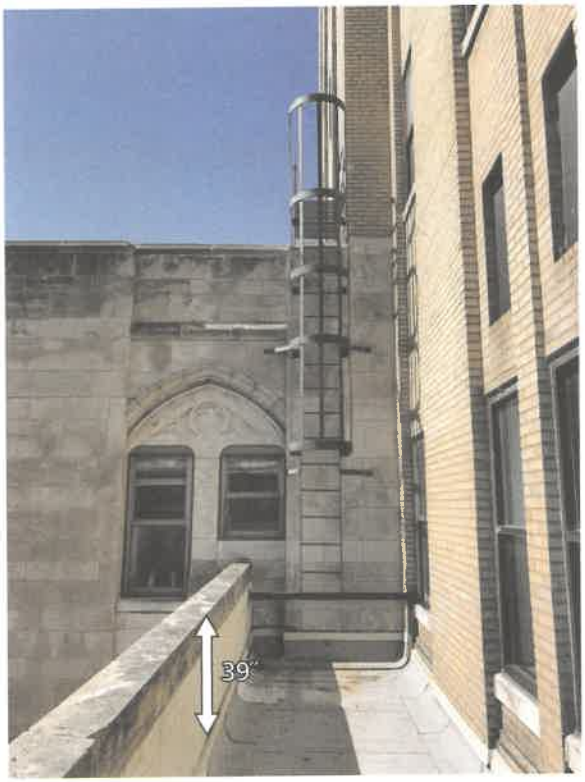
are followed during guardrail construction. Because these regulations are not all the same, the most stringent regulations that apply to a given locale or work situation must be followed. Contractors or project managers may enforce additional safety rules, and these must be followed as well.

TRADE TIP

The top rail must support a minimum of 200 pounds in all directions.

Top Rails The minimum height that OSHA has set for top rails or equivalent guardrail system members is 42″, plus or minus 3″, above the walking or working surface. OH&S requires that top rail height be a minimum of 36″ and a maximum of 42″; the midrail must be half of the distance between the top rail and the work surface. When workers will be using stilts, the top edge of the top rail or equivalent member must be increased in height by a distance equal to the height of the stilts. Figure 11 shows proper top rail placement. The top guardrail must be capable of withstanding a force of at least 200 pounds applied within 2′-0″ of any point along the top edge in any outward or downward direction. A parapet wall can act as a top rail, provided it is at least 39″ in height. A parapet wall is designed to hide the roof equipment, such as rooftop mechanical units or exhaust fans that may be above the roof elevation. Figure 12 shows a parapet wall being used as a top rail.

FIGURE 12
Parapet wall top rail



Midrails Not all guardrails require a midrail, but when midrails are used, they must be installed at a height that is midway between the top edge of the guardrail system

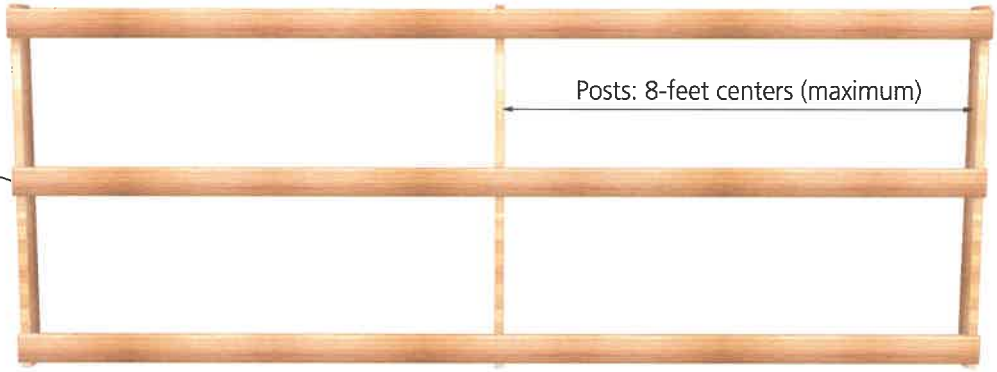


FIGURE 13
Proper midrail placement

TRADE TIP

Midrails are not required along a walking path but are required around an active work area.

and the walking or working level. Proper midrail placement is shown in Figure 13. A parapet wall could act as a midrail, provided it is at least 21″ high. Figure 14 shows a parapet wall being used as a midrail. Additional midrails and other structural members or architectural panels must be installed so that there are no openings wider than 19″ in the guardrail system. Midrails, 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.

FIGURE 14
Parapet wall midrail

Manila Rope, Synthetic Straps, or Wire Rope Various types of sturdy ropes or straps can be used for top rails and midrails, so long as they conform to the same strength requirements as required by OSHA and OH&S standards. Manila rope is made from natural plant fibers, whereas synthetic

straps are made of man-made fibers. Figure 15 shows a manila rope guardrail system. One of the more versatile guardrail types in use today is a system made of synthetic straps that are tension-fitted to conform to any jobsite application, as shown in Figure 16. Wire rope used for top rails or midrails must have a nominal diameter or thickness of at least ¼″ to prevent cuts and lacerations, and must be flagged at no more than 6′-0″ intervals with high-visibility material. See Figure 17. When manila rope, synthetic straps, or wire rope are used for guardrail members, they must be regularly inspected to ensure they are not worn, frayed, stretched, or broken. Damaged rope, strap, or other damaged guardrail materials should be replaced immediately.

FIGURE 15
Manila rope guardrail system

FIGURE 16
Synthetic guardrail system

FIGURE 17
Flagged wire rope

FIGURE 18
Guardrail system with toeboards

Toeboards Toeboards are placed along the edge of walkways or working surfaces and should be long enough to protect all areas where tools and materials may slide or roll over the side and endanger anyone below. According to OSHA, toeboards must be a minimum of 3 ½″ in height from their top edge to the surface of the walkway or working area and must be capable of supporting at least 50 pounds of pressure in either a downward or outward direction. No more than a ¼″ gap is allowed between the bottom of the toeboard and the working surface. When materials for toeboards are butted together, they cannot have more than a 1″ gap between them. Additional protection may be required where tools, equipment, or materials are piled higher than the top edge of a toeboard. This may consist of paneling or safety nets extending from the walkway, working surface, or toeboard to the top rail or midrail of the guardrail system. All applicable local, state, provincial, or federal regulations should be followed during the placement of toeboards. Toeboard requirements are different in Canada; OH&S requirements state that they must be a minimum of 5 ½″ high. Figure 18 shows a guardrail system with toeboards.

PRODUCTIVITY TIP

Toeboards must be installed on guardrails if any materials or tools will be placed on the walking or working surface to prevent them from falling over the edge.

Vertical Netting Vertical netting is sometimes used to provide additional protection from falls or falling objects. A guardrail system with vertical netting is shown in Figure 19. According to OSHA and OH&S requirements, the netting must extend from the top rail to the surface of the walkway or working level and along the length of the entire opening between top rail supports.

Guardrail Safety Considerations Guardrail systems must be smooth enough to prevent cutting workers or snagging their clothes. During guardrail installation, the creation of hazardous projections such as an overextended top rail or midrail at a corner must be avoided. Figure 20 shows a guardrail with dangerous corner projections.

FIGURE 19
Vertical netting

FIGURE 20
Guardrail with dangerous projections

Guardrail Applications Guardrails are used in many different locations and circumstances to control or minimize fall hazards. To effectively serve their purpose and protect workers, guardrails must be properly installed and maintained. Requirements vary depending on the use and placement of the guardrails. The following are four common examples of guardrail applications.

FIGURE 21
Guardrail with chain access

Hoisting Areas Guardrails are often installed to help prevent falls in areas where hoists are used to raise or lower tools, materials, and personnel. These guardrail systems must have openings to provide access, and when the hoisting area is not in use a chain, gate, or removable section must be placed across the access opening to guard against falls. Examples of hoisting-area guardrails are shown in Figures 21, 22, and 23. When the chain, gate, or removable guardrails are opened or removed to provide access to the hoisting area, OSHA and OH&S regulations require that personal fall protection gear be worn by all personnel in the area.

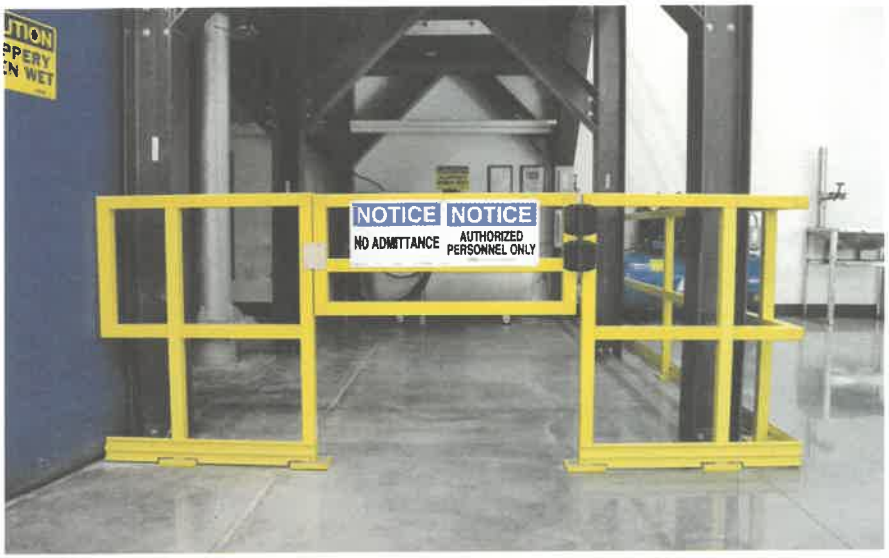


FIGURE 22
Guardrail with gate access

SAFETY TIP

Steel or plastic banding cannot be used as top rails or midrails because these materials do not meet safety standards.

FIGURE 23
Guardrail with removable section

FIGURE 24
Wall openings

Openings An opening is a gap in a wall or partition through which a worker could fall to a lower level. Openings include door and window openings. Protection is required for each employee that will work on, at, above, or near wall openings where the outside bottom edge of the opening is 6′-0″ or more above lower levels and the inside bottom edge of the wall opening is less than 39″ above the working or walking surface. Examples of wall openings are shown in Figure 24. In some cases, guardrails are placed around openings being used as access points for personnel, such as at the top and bottom of ladderways. These guardrails must have gates, such as the one shown in Figure 25. The point of access must be sufficiently offset to prevent workers from accidentally walking through the opening.

FIGURE 25
Gate in a ladderway guardrail

Ramps and Runways Personnel using ramps or runways may be vulnerable to falls. To minimize the fall hazard, guardrails can be installed along each side or edge of the ramp or runway, as shown in Figure 26. According to OSHA and OH&S, guardrails must be erected on each unprotected side or edge when ramps and runways are 6′-0″ or more above a lower level.

Leading Edges A leading edge is an unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surface, such as a deck, that changes location as additional floor or roof decking or formwork sections are placed, formed, or constructed. A leading edge is shown in Figure 27. When framing, sheathing, or other work is to be done on either sloped or flat roofs, gable ends, or parapet walls, the edge may be protected by a guardrail system. These guardrail systems will remain in place until the work has been completed. Figure 28 shows a roof edge guardrail system.

FIGURE 26
Runway guardrails

FIGURE 27
Example of a leading edge

FIGURE 28
Roof edge guardrail system

FIGURE 29
Tagged component

Guardrail Inspection and Maintenance Guardrail systems, whether permanent or temporary, should be inspected by a competent person each day before work begins or whenever the jobsite has been changed in any way that may alter existing fall hazards or introduce new ones. Any required maintenance should be attended to immediately. Guardrail systems must be suitable for their intended purposes and must meet all relevant local, state, provincial, and federal regulations and requirements. The most stringent regulations must always be followed in each situation. Permanent systems with bolts, welds, or other surface-penetrating attachments should be checked regularly for signs of wear, detachment, or damage. Guardrails should be inspected for bent or loose connections and rusty or corroded components. Temporary guardrail systems should be continuously checked because they are constantly being moved, reconfigured, or dismantled, which increases the likelihood of wear or damage. The movement, reconfiguration, and dismantling of guardrail systems should be supervised by a competent person. All defective components should be properly tagged and removed from service immediately. Figure 29 a shows a properly tagged component.

SELF CHECK

1. Why are guardrails often painted yellow?
2. Describe the proper placement of midrails.
3. Explain how toeboards help protect workers.
4. List and describe four common guardrail applications.
5. What is a leading edge?

FIGURE 30
Tower safety net

Safety Net Systems

The use of safety nets is another highly effective method of protecting workers from falls and falling objects. A **safety net** is made from synthetic materials and is designed to catch falling debris, a fallen worker, or a combination of both. Safety net systems are often used in conjunction with guardrails, and are designed to catch falling debris before it strikes and injures someone below or to quickly catch a fallen worker in time to prevent serious or fatal injuries. Safety nets are used on towers, silos, bridges, around scaffolds, at the edges of tall building, and in many other places or circumstances in which there is the possibility of becoming injured by a fall or falling objects. Examples of safety net uses are shown in Figures 30, 31, and 32. Some safety nets are designed to catch falling tools and debris, while others are used for fall protection for workers. Some specially designed safety nets can be placed over skylights to safely catch workers that may accidentally step into them. Some manufacturers design safety nets that can be used as an anchor for a leading edge by using the structure of the skylight as an anchor point. Figure 33 shows a skylight safety net with an anchor attachment.

FIGURE 31
Bridge safety net

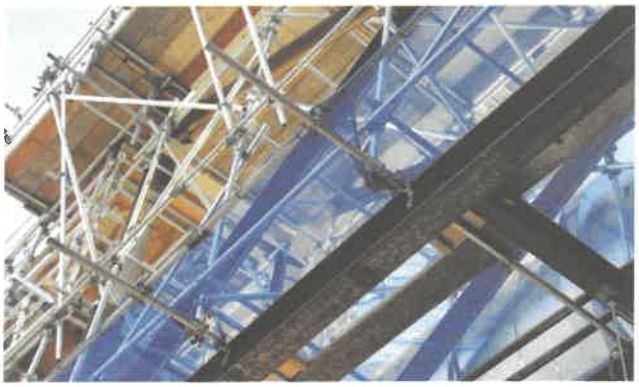


FIGURE 32
Scaffold safety net

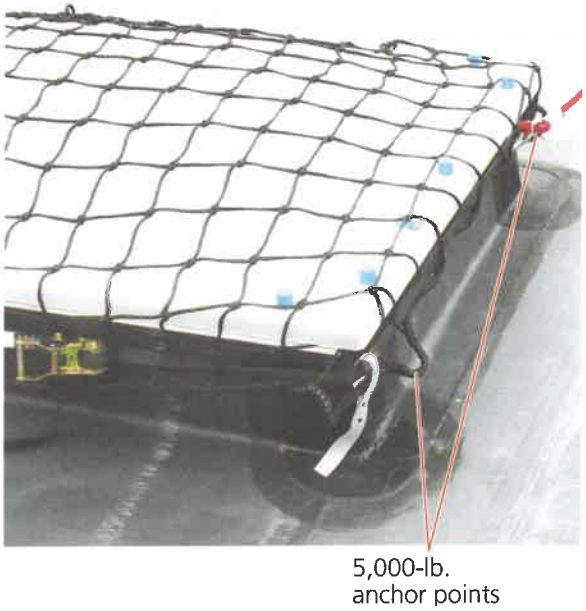


FIGURE 33
Skylight safety net

SAFETY TIP

Safety nets must be installed with sufficient clearance underneath to prevent contact with the surface or structure below.

Safety Net Guidelines In order to provide effective fall protection, safety nets should be properly installed and placed as close as practically possible to the protected walkway or working surface. OSHA regulations state that nets should never be more than 30′-0″ below the protected surface. The potential fall area must be unobstructed and the nets must extend outward from the outermost projection of the work surface as follows:

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

In Canada, the OH&S standards require that an employer ensure the following characteristics of a safety net:

- meets the requirements of ANSI Standard A10. 11-1989 (R1998), Construction and Demolition Operations—Personnel and Debris Nets
- has safety hooks or shackles of drawn, rolled, or gorged steel with an ultimate tensile strength of not less than 4990.75-lb

SAFETY TIP

A safety net must be anchored to a structure according to the manufacturer's guidelines to ensure that the safety net does not fail.

- has joints between net panels capable of developing the full strength of the web
- extends not less than 7′-10 ½″ beyond the work area
- extends not more than 19′-8 ¼″ below the work area
- is installed and maintained so that the maximum deflection under impact load does not allow any part of the net to touch another surface

FIGURE 34
Inspecting safety nets

Inspection and Maintenance of Safety Net Systems Regular inspection and maintenance of safety nets must be performed to ensure that the nets will serve their intended purpose without failure. Safety nets should be inspected by a competent person for wear, damage, and other deterioration at least once a week and immediately after any change or event, such as a fall or severe weather, that may affect the integrity of the system. Defective nets must be removed from service and immediately replaced. Figure 34 shows a competent person checking a safety net for damage and Figure 35 shows an example of safety net damage.

Damage to safety net

FIGURE 35
Damage to safety net

SAFETY TIP

Any debris in a safety net must be removed immediately to prevent injury to workers in the event of a fall.

Safety nets are designed to be lightweight and rot-resistant, and are manufactured from synthetic materials that make them vulnerable to certain types of damage. For example, damage may result from improper use, handling, or storage, as well as by wear and tear, heat, or flame. The effectiveness and durability of safety nets can be adversely affected by weathering, UV degradation, and various other environmental factors. Safety nets must be stored in a dry place. The manufacturer's specifications and guidelines for proper installation, use, and storage must always be followed.

Hole Covers

Working near unguarded holes, openings, or skylights can significantly increase the risk of falls. To help prevent falls and fall-related injuries or fatalities, all holes and similar openings should have secured covers such as the ones shown in Figure 36. A **hole cover** is a physical barrier placed over a hole or opening in the working or walking surface that will prevent a person or object from falling through. Some smaller holes can be covered with reusable manufactured hole covers that are available in custom sizes. Holes may also have guardrails and toeboards around the opening for protection.

SAFETY TIP

Hole covers must be secured and labeled with the word "HOLE" or "COVER" to warn employees of the hazard.

Typical plywood hole cover

Fits holes 2″–6″ in diameter

Comes in ½″ increments from 2″–6″, 7″, 8″, and 9″

Fits holes 2″–6″ in diameter

FIGURE 36
Various types of hole covers

Hole Cover Uses Covers are required to protect employees from tripping into, stepping into, or falling through holes, gaps, and skylights. Covers will also protect employees working below from objects that may fall through

holes and skylights. Covers are used primarily on walking or working surface openings that are more than 6′-0″ above lower levels.

Hole Cover Regulations Because holes and similar openings are responsible for many work-related accidents, OSHA and OH&S have extensive regulations regarding when and how they must be covered. OSHA defines a hole as "a gap or void 2 or more inches in its least dimension in a floor, roof, or other walking or working surface." See Figure 37.

FIGURE 37
Uncovered hole

By OSHA standards, covers used to guard holes and skylights must be capable of supporting at least twice the weight of any workers, equipment, or materials likely to be placed on them at any one time. Covers must be secured when installed to prevent accidental displacement by wind, equipment, or workers. They must be color-coded, such as yellow for gas lines, or labeled with "HOLE" or "COVER" to warn personnel that a hazard is near. Figure 38 shows a properly installed and marked cover.

SAFETY TIP

Hole covers that may become covered with snow should be surrounded by guardrails.

FIGURE 38
Marked hole cover

Hole Cover Guidelines While carefully observing government regulations and industry standards can help prevent most falls and fall-related injuries, following work rules and the use of vigilance and good common sense can make construction sites even safer places to work. Good housekeeping habits and showing consideration for fellow workers can make important contributions to safety as well. The following guidelines should also be followed:

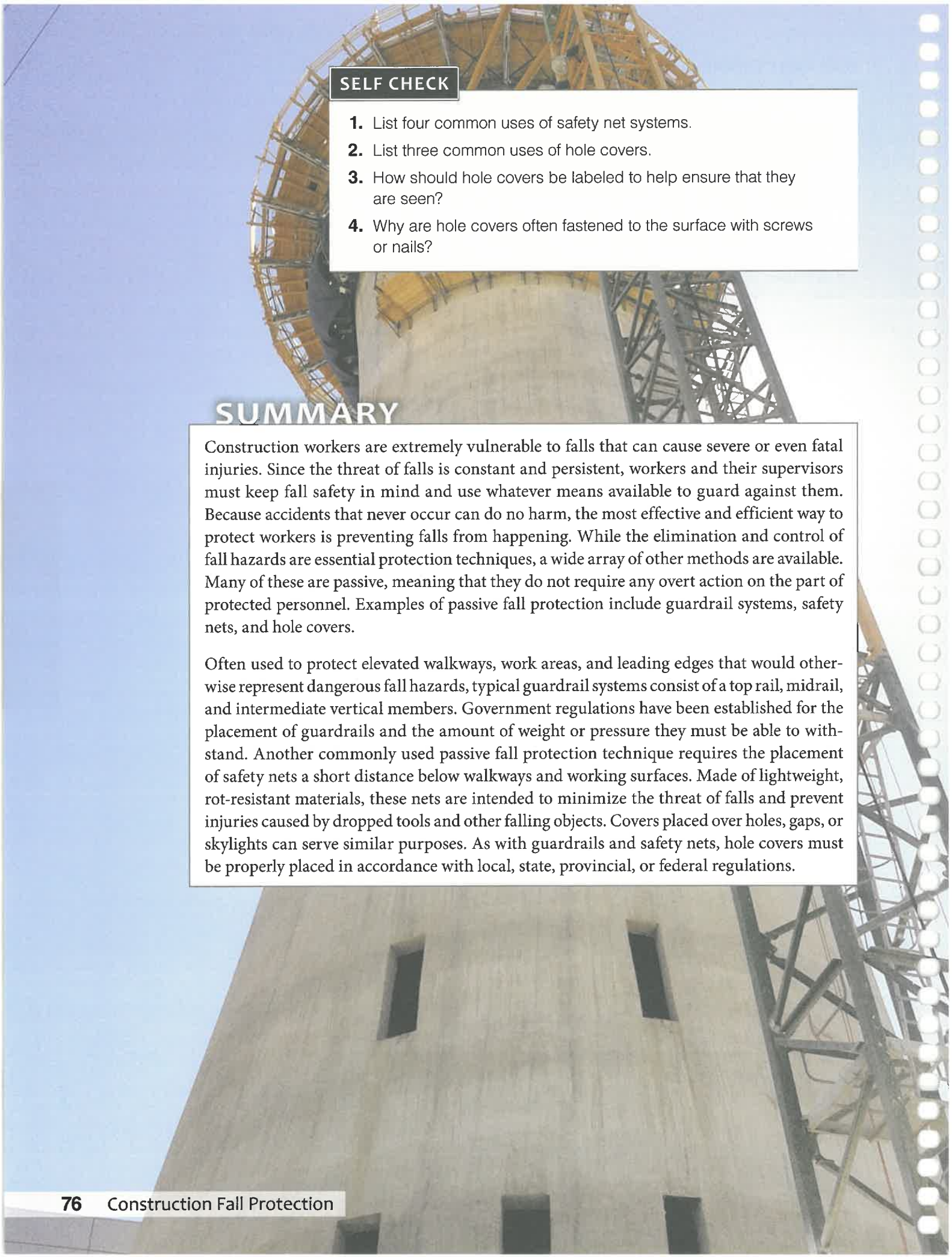
- Whenever a hole or other dangerous opening is identified, created, or uncovered, it should be properly covered before leaving the work area.
- All covers should be properly labeled with the word "HOLE" or "COVER" to warn approaching personnel.
- If a hole is created, uncovered, or seen without a guardrail, it should be covered before the work area is exited, as it is possible that other workers might not notice the uncovered hole and could fall through.
- Covers must be able to support at least two times the weight of workers, equipment, and materials.
- All covers must be fastened securely to prevent them from moving and possibly exposing the hole. If a worker steps on an unsecured cover, it may shift, causing the worker to fall through the hole and be injured.
- Any hole or gap that may be too large to be covered must be protected by guardrails, as per OSHA regulations.
- Roofs must be inspected for any holes or skylights.
- All holes must be covered, secured, and marked, even if they will only be open for a short time.

Construction workers should follow all relevant local, state, federal (OSHA), and provincial (OH&S) regulations. Since these regulations are not all the same, the contractor and worker must follow the most stringent regulations that apply to a given locale or work situation.

FALL AWARENESS SCENARIO

A heating, ventilation, and air-conditioning (HVAC) contractor was working alone while inspecting an air-conditioning unit on the flat roof of a converted warehouse when he fell through an unguarded skylight to the concrete floor below. He died 19 days later from his injuries. The skylight did not have any protective screen or guardrail at the time of the incident. The contractor was an owner-operator and did not have any written policies, procedures, or safety documents.

- How could this tragic incident have been prevented?
- Have you ever known anyone who fell because a skylight was unprotected?



SELF CHECK

1. List four common uses of safety net systems.
2. List three common uses of hole covers.
3. How should hole covers be labeled to help ensure that they are seen?
4. Why are hole covers often fastened to the surface with screws or nails?

SUMMARY

Construction workers are extremely vulnerable to falls that can cause severe or even fatal injuries. Since the threat of falls is constant and persistent, workers and their supervisors must keep fall safety in mind and use whatever means available to guard against them. Because accidents that never occur can do no harm, the most effective and efficient way to protect workers is preventing falls from happening. While the elimination and control of fall hazards are essential protection techniques, a wide array of other methods are available. Many of these are passive, meaning that they do not require any overt action on the part of protected personnel. Examples of passive fall protection include guardrail systems, safety nets, and hole covers.

Often used to protect elevated walkways, work areas, and leading edges that would otherwise represent dangerous fall hazards, typical guardrail systems consist of a top rail, midrail, and intermediate vertical members. Government regulations have been established for the placement of guardrails and the amount of weight or pressure they must be able to withstand. Another commonly used passive fall protection technique requires the placement of safety nets a short distance below walkways and working surfaces. Made of lightweight, rot-resistant materials, these nets are intended to minimize the threat of falls and prevent injuries caused by dropped tools and other falling objects. Covers placed over holes, gaps, or skylights can serve similar purposes. As with guardrails and safety nets, hole covers must be properly placed in accordance with local, state, provincial, or federal regulations.

Hazard Elimination and Passive Fall Protection

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. An opening is a gap in a wall or partition through which a worker could fall to a lower level. (True; False)

2. An unprotected side and edge of a floor, roof, or formwork for a floor or other walking or working surfaces such as a decks that changes location as additional floor or roof, decking of formwork sections are placed, formed, or constructed is known as a(n) _____ _____.

3. Poles to which screw guns or other tools may be attached for use in overhead applications are often referred to as ____.
   a. lift poles
   b. extra-reach tools
   c. tool extensions
   d. overhead tool lifts

4. Changing work procedures, redesigning the working environment, installing secure guardrails, and placing safety nets are all examples of ____ fall protection.
   a. active
   b. passive
   c. personal
   d. impersonal

5. Wet or muddy surfaces, sudden changes in grade, cluttered walkways, and unmarked or unprotected holes or openings are all examples of ____.
   a. administrative controls
   b. good housekeeping
   c. passive fall protection
   d. hazardous conditions

6. The most effective way to protect workers from falls is to _____ exposure to fall hazards.

7. A guardrail system is a(n) _____ installed to prevent personnel from falling while working or moving from place to place on elevated walkways or working surfaces.

8. Guardrails are often painted ____ so they can be easily seen.
   a. red
   b. gray
   c. yellow
   d. black

9. Intended to remain in place throughout the project, a(n) _____ guardrail can be bolted or welded to steel or even embedded in concrete.

10. According to OSHA, the minimum height for top rails or equivalent guardrail system members is ____.
    a. 16″, plus or minus 3″
    b. 42″, plus or minus 3″
    c. 24″, plus or minus 2″
    d. 48″, plus or minus 6″

11. Generally lightweight and easily installed or removed by a single person, _____ guardrails often consist of only a basic rail system.

12. In a guardrail system, midrails, intermediate vertical members, solid panels, and equivalent structural members must be capable of withstanding a force of at least ____.
    a. 100 pounds
    b. 120 pounds
    c. 150 pounds
    d. 180 pounds

13. Manila or synthetic rope can be used for top rails and midrails, but must conform to the same strength requirements set forth by OSHA and OH&S standards. (True; False)

14. When wire rope is used for top rails or midrails, it must be flagged at intervals of ____.
    a. not more than 6′-0″
    b. not more than 8′-0″
    c. not more than 10′-0″
    d. not more than 12′-0″

15. According to OSHA, toeboards must be a minimum of ____ from their top edge to the surface of the walkway or working area.
    a. 2″
    b. 2 ½″
    c. 3 ½″
    d. 5 ½″

16. According to OH&S, toeboards must be a minimum of ____ from their top edge to the surface of the walkway or working area.
    a. 2″
    b. 2 ½″
    c. 3 ½″
    d. 5 ½″

17. When guardrails are used in hoisting areas, they must have openings to provide access, and when the hoisting area is not in use, a chain, gate, or removable section is placed across the access opening to guard against falls. (True; False)

18. The process of moving, reconfiguring, or dismantling guardrail systems should be supervised by a(n) _____ _____.

19. According to OSHA and OH&S, safety nets should never be more than _____ below the protected surface.
    a. 30′-0″
    b. 35′-0″
    c. 40′-0″
    d. 45′-0″

20. Designed to be lightweight and rot-resistant, safety nets are manufactured from _____ materials that make them vulnerable to certain types of damage.

21. Safety nets may be designed to catch falling tools and debris, while others are used for fall protection for workers. (True; False)

22. To meet the OSHA and OH&S definition of a hole, a gap or opening in a floor, roof, or other walking or working surface must be at least _____ wide in its least dimension.
    a. 2 or more inches
    b. 3 or more inches
    c. 4 or more inches
    d. 6 or more inches

23. Hole covers are intended to serve as _____ barriers that will prevent workers, tools, and other objects from falling through the opening.

24. All covers should be properly labeled with the word "HOLE" or "COVER" to warn personnel that they are approaching a hazard. (True; False)

25. Any hole or gap that is too large to be covered must be protected by _____.

WORKSHEET 1

Safe or Unsafe

Instructions Not all of the scenes in the figures below are safe. Place a check mark by either S for safe or U for unsafe. If unsafe, explain why in the blank provided.

1.

S____ U____

_____

_____

2.

S____ U____

_____

_____

Safe or Unsafe (continued)

3.

S ____ U ____

4.

S ____ U ____

Safe or Unsafe (continued)

5.

S____ U____

_____

_____

6.

S____ U____

_____

_____

7.

S____ U____

_____

_____

WORKSHEET 2

Fall Awareness Scenario

Instructions Read the scenario below. Working in teams, determine the corrective actions required to prevent this type of tragedy from reoccurring. Each team will report their findings.

A 22-year-old male carpenter's apprentice—the victim—died of injuries he received after crawling from an unprotected floor edge onto an unsecured piece of plywood and falling 120 feet to the ground. At the time of the incident, concrete forming work had been completed on 12 floors of a condominium that was under construction. The victim was part of a crew removing form materials—plywood, etc.—and was assigned to work on the 10th floor. The victim had been on the 12th floor obtaining a safety harness and was en route to the 10th floor via a personnel hoist when he stopped the hoist and exited at the 11th floor. A coworker from the floor above had yelled down to the victim, asking him to plug in an extension cord that was hanging from the 12th to the 11th floor. He crawled under a red tape warning line at the floor edge of the atrium and onto a piece of unsecured plywood. The plywood gave way and the victim fell 120 feet to the ground. The local emergency medical service responded in less than 10 minutes, but the victim was pronounced dead at the scene.

The employer in this incident was a concrete forming company that had been in business for 15 years and had 15 employees. The employer had been contracted to supply the concrete forming work for the construction of a 12-story condominium. The employer did not have a written safety and health program, but did hold biweekly safety meetings. In addition, the owner was the designated safety officer. The victim had worked for the employer for 9 days. This is the first fatality experienced by the employer.

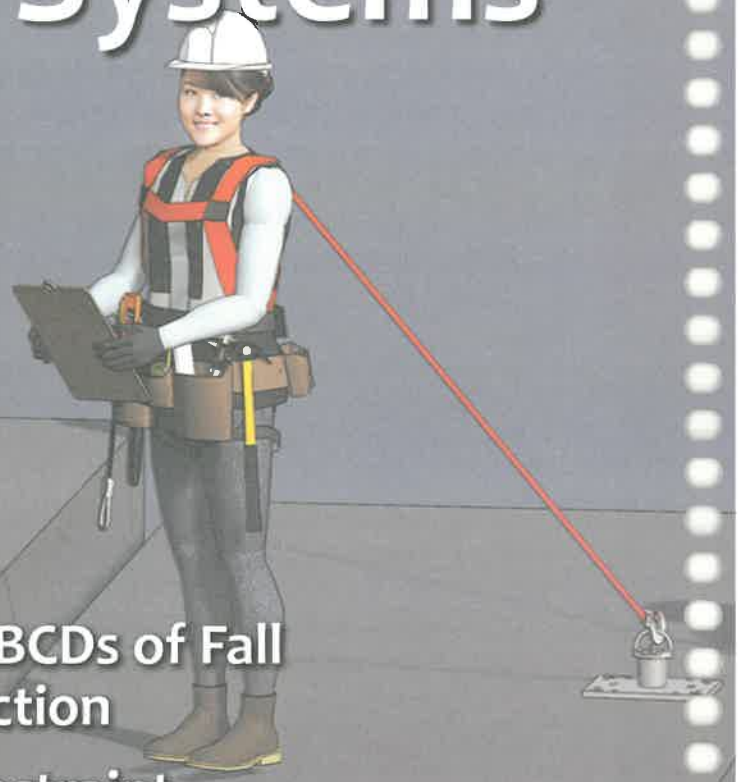
A warning line consisting of red danger tape and manila rope tied to rebar and strung along the atrium floor edge was being used in lieu of a guardrail system at the time of the incident.

NIOSH investigators concluded that to prevent similar occurrences employers should take the following corrective actions.

1. _____
2. _____
3. _____

CHAPTER

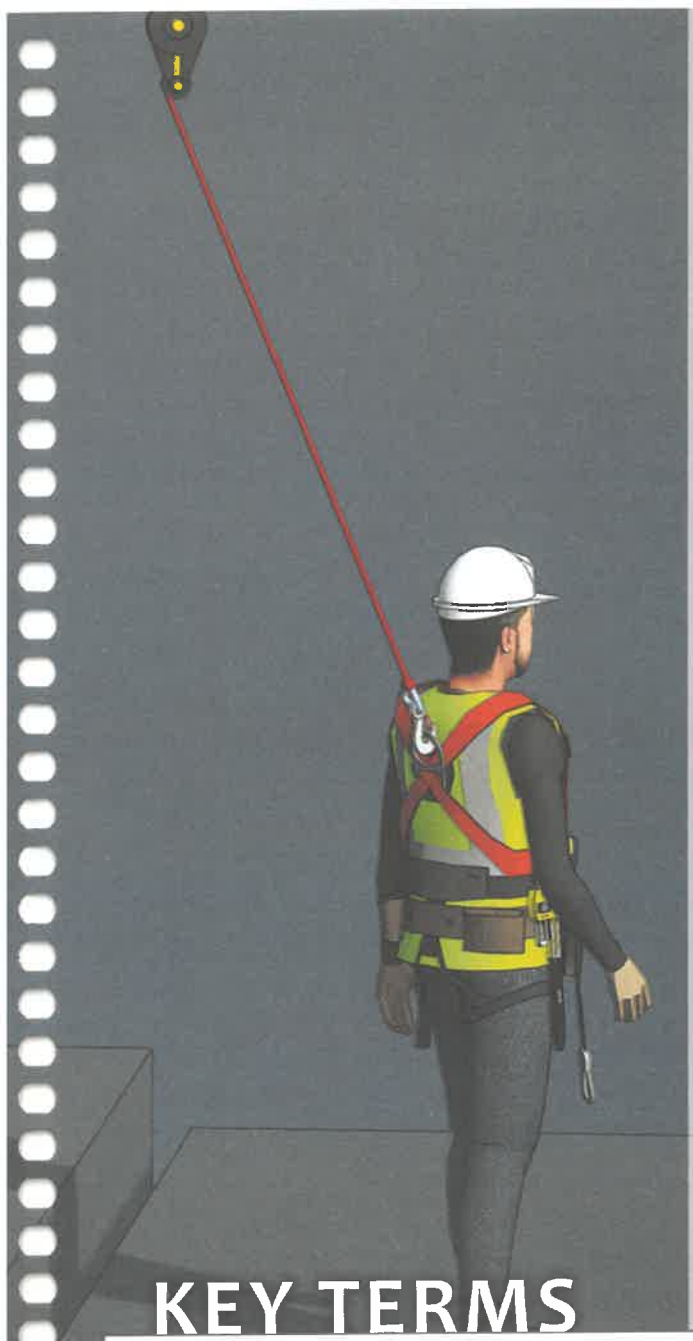
4 Personal Fall Restraint and Arrest Systems



INTRODUCTION

Fall protection systems and techniques are not intended to prevent falls. Instead, they are meant to slow and then stop a falling worker in time to prevent serious injury and to make it easier to rescue a fallen worker. This chapter outlines the ABCDs of Fall Protection: Anchorage, Body Support, Connection, and Descent/Rescue. It also describes personal fall arrest systems (PFASs) and personal fall restraint systems, along with various types of lanyards, lifelines, and other equipment that can be used with them. Additional sections are devoted to safe descent and rescue equipment and techniques, executing rescues in confined spaces, and suspension trauma that may occur if fallen workers do not receive prompt assistance.

CONTENTS



OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. List and describe the four fundamental requirements that must be met by every fall protection system.
2. Describe a personal fall arrest system and explain how it protects workers from falls and fall-related injuries.
3. Describe four types of fall protection lanyards.
4. Describe a positioning device system and explain how it is used to protect workers from falls and fall-related injuries.
5. Explain how vertical lifelines are used to protect workers from fall-related injuries.
6. List and describe five key elements of an emergency response plan.
7. List five actions that should be taken after a fall rescue has been completed.
8. Explain why confined space rescues are exceptionally difficult and describe three types of special equipment that may be used to safely complete them.
9. Explain how suspension trauma occurs, why it is so dangerous, and how it can be prevented.

KEY TERMS

Key Terms are in order of appearance.

personal fall arrest system (PFAS) safety system consisting of an anchorage, connectors, and full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall

anchorage secure connecting point capable of safely withstanding the forces exerted on a fall protection system during a fall

anchorage point secure place of attachment for lifelines, self-retracting devices (SRDs), and lanyards

swing fall condition that exists when a worker's anchorage point is not directly above the worker, causing the worker's body to act like a pendulum when the worker falls

full-body harness fall protection equipment made of strapping that secures the worker in a manner that will distribute the fall arrest forces over the thighs, pelvis, waist, chest, and shoulders

connector device used to attach parts of the personal fall arrest system to an anchorage point

rope grab friction-activated device that automatically engages a lifeline and locks to stop a falling worker

suspension trauma effect that occurs when the human body is held upright without any movement for a period of time

positioning device body harness system that allows a worker to work hands-free and to be supported on an elevated vertical surface

Continued on next page

KEY TERMS (continued)

lanyard flexible length of fiber rope, wire rope, or strap that can be securely attached to a body harness, deceleration device, lifeline, or anchorage

deceleration device mechanism designed to slow a falling worker and dissipate or limit the kinetic energy imposed on the worker during a fall arrest; also known as a shock-absorbing device

self-retracting device (SRD) retractable lanyard that relies on inertia to activate a braking mechanism housed in a specially designed block

vertical lifeline flexible length of rope or wire rope that connects to an anchor point at one end and is to be used with a rope grab along its length

horizontal lifeline synthetic fiber rope, wire rope, or rail system used as part of a complete personal fall arrest system that attaches between two anchor points

1 The ABCDs of Fall Protection

Although hazard elimination is always the most effective way to protect workers from the severe injuries associated with falls, it is nearly impossible for every construction site fall hazard to be eliminated. Some such hazards may be overlooked, while others cannot be adequately controlled. Still others may be created as a project moves forward or may be an inevitable part of the construction process itself. Since construction work often must be done at elevation, efficient and effective means must be found to safeguard workers or limit the severity of their injuries in the event of a fall. This is referred to as fall protection and will typically involve the use of a suspension system designed to decelerate and then stop a falling worker, causing only minimal injuries.

When working at heights, construction personnel can be protected with a **personal fall arrest system (PFAS)**, a safety system consisting of an anchorage, connectors, and full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall. A PFAS can provide effective fall protection only if all elements of the system work together as intended and are backed up by a prompt and safely executed descent and rescue effort. These required elements are referred to as the ABCDs of Fall Protection.

- Anchorage
- Body Support
- Connection
- Descent/Rescue

To provide workers with the necessary level of protection, each of these elements must be in place. All fall protection equipment must be clean and in excellent working condition, and personnel must be properly trained in its use. Careful consideration must be given to the selection of equipment appropriate for each job, and equipment should be carefully inspected before

each use. Proper maintenance is essential, and any worn or damaged equipment must be tagged and taken out of service immediately. Whenever work is to be done at heights and fall protection equipment will be used, trained personnel must be available to promptly execute descent and rescue procedures. Figure 1 illustrates the components of the ABCDs of Fall Protection.

FIGURE 1
ABCDs of Fall Protection

A – Anchorage

Anchorage devices provide a secure point of attachment for the fall arrest system. Anchorage devices can be permanent or temporary and vary to suit the type of structure available.

C – Connector

Connectors are devices that connect the full body harness to the anchorage system. They can be single products or multiple devices working together.

B – Body Support

Full-body harnesses connect the worker to the fall arrest system. They are specifically designed to protect the worker against serious injury in the event of a fall while also remaining comfortable to wear.

D – Descent / Rescue

Descent and Rescue systems enable the retrieval of an injured or incapacitated worker. In the event of a rescue, this equipment facilitates rapid recovery of the worker without endangering other workers in the process.

Anchorage

An **anchorage** is a secure connecting point capable of safely withstanding the forces exerted on a worker and the worker's fall protection system during a fall. These forces may be far greater than the weight of the falling worker. Engineered and certified anchorage must meet OSHA and OH&S standards. If the weight likely to be placed on an anchorage is uncertain, a competent person must approve the anchorage before workers' lives are entrusted to it. Once an anchorage has been selected, it can be used only as an attachment point for a PFAS or other fall protection system and for no other purpose. For instance, it cannot be used to support or suspend platforms. Examples of secure anchorages are shown in Figure 2.

SAFETY TIP

Safe points of anchorage may include structural members of buildings but do not include guardrails, standpipes, vents, or other piping systems as they do not meet the required strength for anchorage points.

Concrete swivel D-ring

Roof ridge anchor

Moveable beam slide

FIGURE 2
Secure anchorages

Certified Anchorage Some anchorages are engineered and certified to be capable of holding the required weight of impact forces. Certified anchorages are determined by a structural engineer who will document and ensure their capacity. Certified anchorages must be capable of holding two times the arresting force for each person attached.

Noncertified Anchorage Most anchorage points are improvised and noncertified. Before a noncertified anchorage can be used, it must be examined by a competent person and judged to be capable of supporting at least 5,000 pounds or more. Since a noncertified anchorage has not been engineered, a higher support weight is required in order to provide a margin of error. According to OSHA and OH&S, fall protection systems connected to noncertified anchorages must limit free-fall distance to 6′-0″ or less and be equipped with an energy-absorbing device that limits maximum arrest forces to 1,800 pounds or less.

Anchorage Points

In order to serve as a part of a PFAS, anchorage must have an **anchorage point**, a secure place of attachment for lifelines, self-retracting devices (SRDs), and lanyards. An anchorage point can be attached directly to a structure or other anchorage and can be either temporary or permanent, such as concrete anchors that may be embedded into the concrete of walls or floors for an anchor point. Removable and reusable bolt-hole anchors, D-bolts, and concrete anchors are shown in Figure 3. Figures 3A, 3B, and 3C are removable anchors that can be reused on other jobsites, depending on the condition of the anchor. The bolt-hole anchors in Figure 3A are placed by pulling back the ring, which will allow the T-lock to swivel. The anchor is then slid through a bolt-hole and locked into place. An expansion bolt is used to anchor the D-bolt in Figure 3B. A hole of the proper size recommended by the manufacturer is drilled into the concrete and the expansion bolt is then placed in the hole to the proper depth. The anchor point and the washer are then placed onto the bolt and the nut is tightened to the proper torque specification. Similar to the D-bolt anchor, a hole will be drilled into the concrete for the concrete bracket anchor shown in Figure 3C. The concrete anchor bracket can then be bolted into the hole. Figure 3D shows a concrete-embedded anchor. This type of anchor is included in the formwork for the concrete and poured in place. The embedded anchor is left in place and has a removable cover for aesthetic purposes. All of these anchorages are reusable, and those shown in Figures 3A, 3B, and 3C are also removable.

Anchorage points may have D-ring attachments or structural steel connecting components, such as beam clamps, to which lifelines and lanyards may

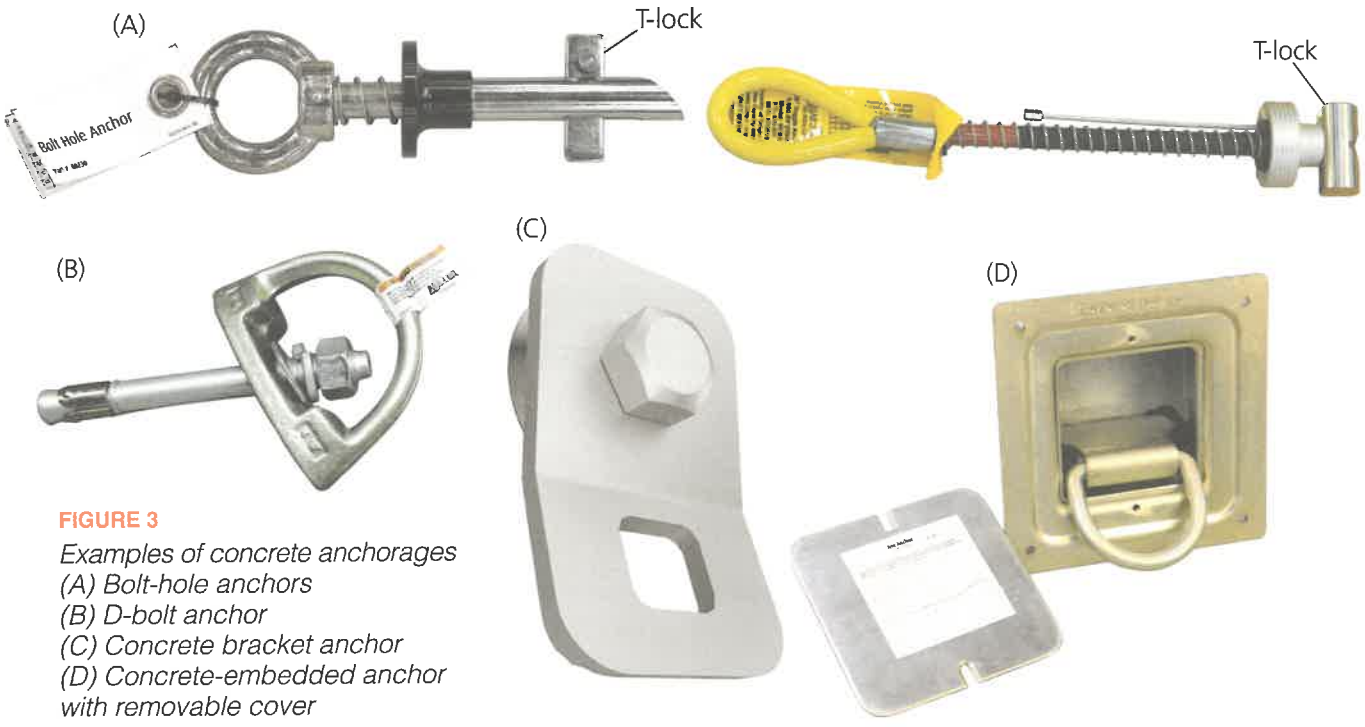


FIGURE 3
Examples of concrete anchorages
(A) Bolt-hole anchors
(B) D-bolt anchor
(C) Concrete bracket anchor
(D) Concrete-embedded anchor with removable cover

FIGURE 4
Vertical lifeline attached to a D-ring

be fastened. Figure 4 shows a vertical lifeline attached to a D-ring, and Figure 5 shows a lanyard attached to a movable beam slide. The anchorage point must be compatible with the lanyard or lifeline and appropriate for the intended load. While strength is critical, the location of an anchorage point is also an important consideration. Whenever possible, the anchorage point should be placed directly above the worker to minimize fall distance and **swing fall**, a condition that exists when a worker's anchorage point is not directly above the worker, causing the body to act like a pendulum when the worker falls. Excessive swing fall may bring a fallen worker into contact with walls and other obstacles, which could cause serious injuries. Figure 6 shows an example of swing fall.

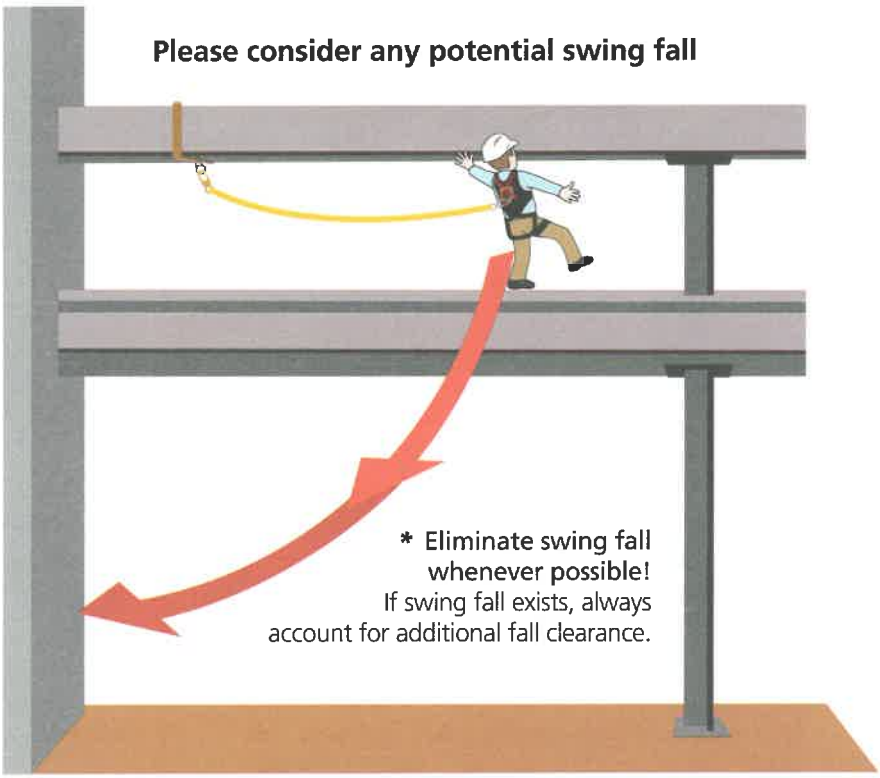
SAFETY TIP

Swing falls are dangerous. As much as possible, always work directly below the anchorage point to avoid swing fall.

Concrete Anchorage Concrete formwork can be used as improvised, noncertified anchorages with the written approval of the manufacturer. Form hooks can be used as single-person anchorage points that attach directly to the form frame. Fall protection systems may include features such as reusable anchors. These anchors are installed in concrete on vertical and overhead concrete surfaces and can be used with horizontal lifelines or concrete anchor straps. These straps are looped around rebar and poured into concrete walls and floors during construction.

FIGURE 5
Lanyard attached to a movable beam slide

FIGURE 6
Swing fall



Movable Beam Slide A movable beam slide is a fall arrest anchorage point that can be attached horizontally to either I-beam or H-beam flanges. See Figure 7. This device slides along the beam as the worker moves, which provides increased safety, mobility, and productivity.

FIGURE 7
Movable beam slide

Stationary Beam Clamp While it does not offer the mobility and other advantages of a movable beam slide, a stationary beam clamp can be attached either horizontally or vertically to I-beam and H-beam flanges. Once tightened, a stationary beam clamp will provide a secure fall arrest anchorage point that can be left in place or relocated whenever necessary. Figure 8 shows an attached stationary beam clamp.

FIGURE 8
Stationary beam clamp

FIGURE 9
Worker in harness

Body Support

In addition to a secure anchorage, a PFAS must have a means to support the worker's body during and after a fall. Among the most common ways of providing this support is a **full-body harness**, fall protection equipment made of strapping that secures the worker in a manner that will distribute the fall arrest forces over the thighs, pelvis, waist, chest, and shoulders. See Figure 9. Designed to keep a worker upright while waiting to be rescued, a full-body harness is attached to a lanyard or self-retracting lifeline by means of a dorsal D-ring in the center of the back near shoulder level. Figure 10 shows how a lanyard is attached to a full-body harness. Full-body harnesses are available in a range of sizes and a variety of styles, some of which are ergonomically sound, which means they are designed to take into account the anatomy, comfort, and necessary movement of the worker. Figure 11 shows a worker adjusting leg straps on a full-body harness.

A full-body harness may include a variety of useful features such as added lumbar support, positioning rings, and tool-carrying capability, as shown in Figure 12. Some harnesses offer extra fire resistance or protection against electrical shock. Some harnesses have been designed for use in special circumstances, and include the following.

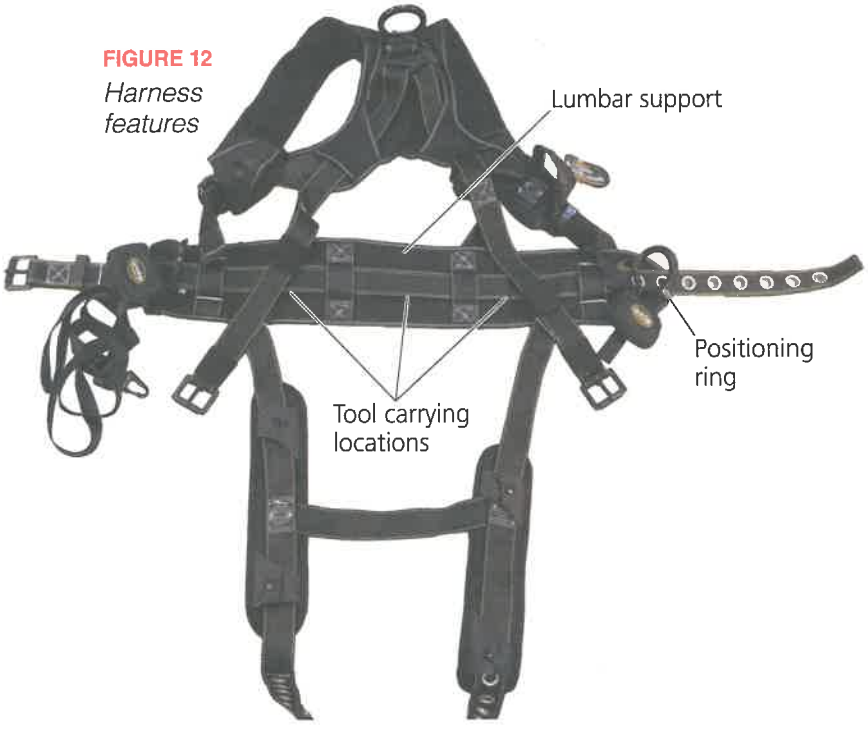
FIGURE 10
Harness attachment point

FIGURE 11
Adjusting a full-body harness

SAFETY TIP

Always follow the manufacturer's instructions when wearing a personal fall arrest system (PFAS). Ignoring these instructions could result in equipment failure that could lead to injury or death if a fall occurs.

FIGURE 12
Harness features



Descent Control/Confined Space Harness These harnesses are equipped with a D-ring attachment point in front or on each shoulder strap to facilitate upright descent and retrieval. Descent control/confined space harnesses such as the one shown in Figure 13 are often used during descent and rescue operations.

Ladder Climbing Harness Equipped with a D-ring attachment point in front, these harnesses can be easily attached to permanent ladder safety systems. Figure 14 shows a worker using a ladder climbing harness.

Work Positioning Harness These harnesses have D-rings located on the hips for use with work positioning lanyards designed to allow hands-free operation. Harnesses of this kind may include built-in waist belts. A work positioning harness is shown in Figure 15.

A fall protection harness is the last line of defense in a fall, but the kind of harness needed will depend on the type of work being done and the environment in which it is performed. The webbing and hardware on a harness is available in a variety of materials to match the work to be performed. Examples include nonconductive material and hardware for electrical work, burn-resistant material for welding, and chemical-resistant material for harsh environments. Harnesses are also manufactured for male and female users.

FIGURE 13
Descent control harness

FIGURE 14
Ladder climbing harness

FIGURE 15
Work positioning harness

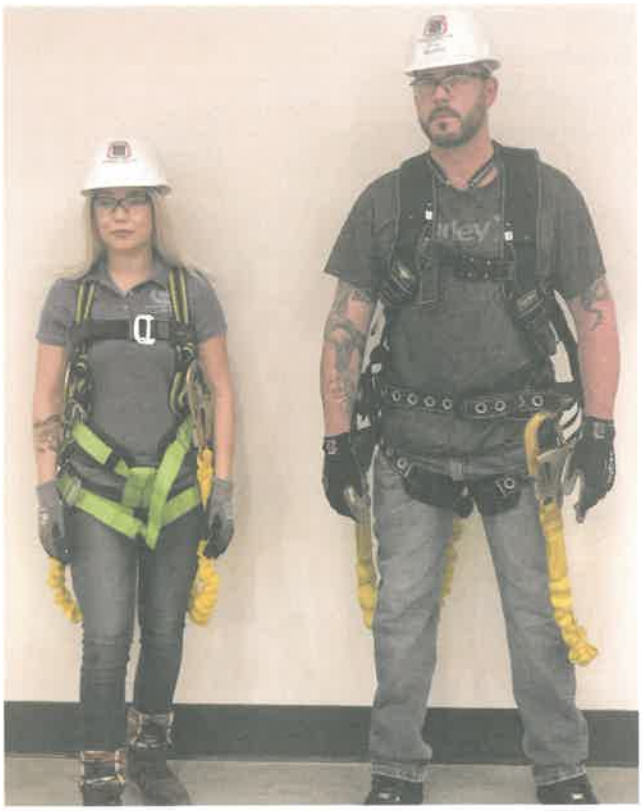


FIGURE 16
Male and female harnesses

The chest straps of a female harness are placed higher, and the shoulder straps are placed farther apart around the chest. Male and female full-body harnesses are shown in Figure 16.

Connection

Connectors are devices used to attach parts of the personal fall arrest system to an anchorage point. Connectors are found on either end of a lanyard, SRL, or a connecting device. These are typically carabiners, snap hooks, and rope grabs, which allow the full-body harness to be connected to the anchorage point. Connectors vary according to manufacturer, industry, and the requirements of the job. It should be confirmed that the tensile strength and the trademark of the manufacturer are stamped on the connector, and that the tensile strength is sufficient for the task at hand. All connectors, regardless of type, must be able to support the intended loads. The following types of connectors or connector components are commonly used in construction.

TRADE TIP

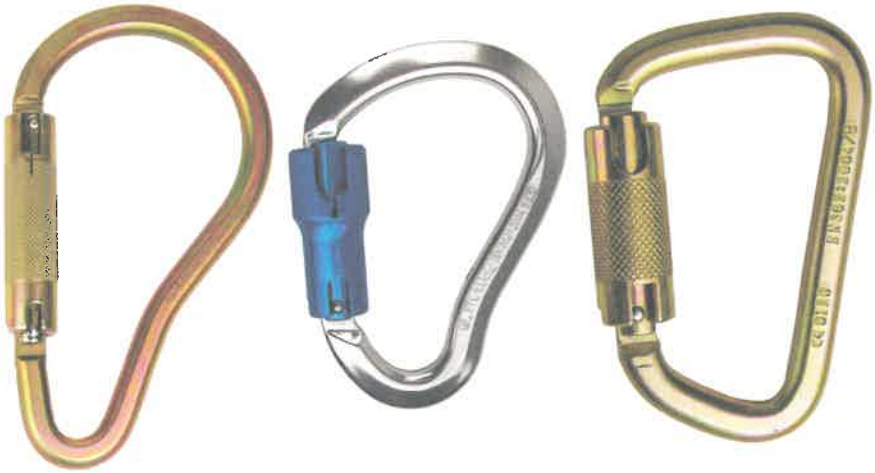
Some manufacturers create harnesses with cross-style chest straps for women.

TRADE TIP

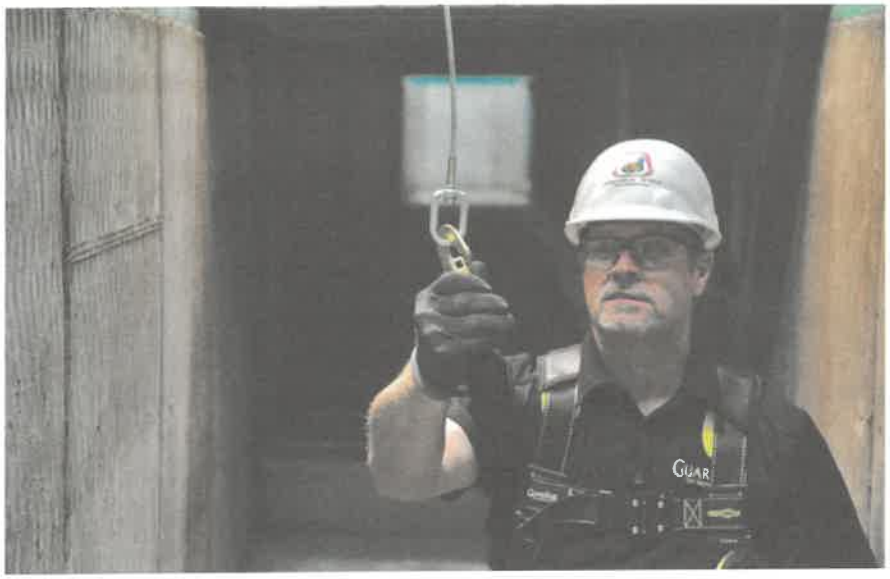
Always check that the tensile strength and the trademark of the manufacturer is stamped on the connector to ensure it supports the intended load.

Carabiners A carabiner is a connector that is usually made of steel or aluminum and has a double-action, self-locking gate that is sometimes referred to as a keeper. Examples of carabiners are shown in Figure 17. Carabiners used in personal fall protection systems must be self-closing and self-locking. For added safety, carabiner locks are double-action, meaning they cannot be opened unless the user takes two separate and consecutive actions.

FIGURE 17
Carabiners



Snap Hook A snap hook is a connecting device consisting of a hook-shaped member with a double-action, self-locking gate that opens to receive a connecting component. The gate automatically closes when released. Another



SAFETY TIP

Injuries or fatalities may occur if conduit, process piping, or vent tubes are used as anchorages or anchorage points for fall arrest.

type of snap hook widely used for larger-diameter anchorages is a pelican hook. A pelican hook is a snap hook with a larger gate and body. Two examples of snap hooks are shown in Figure 18.

Tie-Back Snap Hook A tie-back snap hook is a connecting device specifically designed to seat a lanyard. The lanyard fits into the forged portion of the hook, as shown in Figure 19, to prevent the lanyard from crossing the self-locking gate. This device also has a double-action, self-locking gate that opens to receive a connecting component and automatically closes when released.

Rope Grab A **rope grab** is a friction-activated device that automatically engages a vertical lifeline and locks to stop a falling worker. Rope grabs are used to provide a wider range of movement while performing work. Examples of rope grabs used on synthetic rope and wire rope are shown in Figure 20.

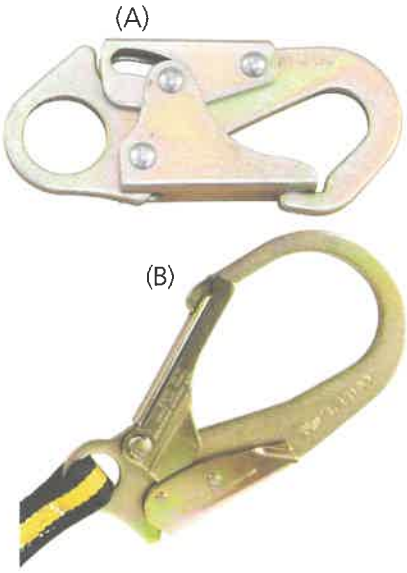


FIGURE 18
Snap hooks
(A) Snap hook
(B) Pelican snap hook

FIGURE 19
Tie-back snap hook

FIGURE 20
Robe grabs

FIGURE 21
Self-rescue

Descent and Rescue

Some construction professionals may mistakenly believe that a secure anchorage, body harness, and connector alone will provide adequate protection from falls and fall-related injuries. After all, these are the ABC elements of a PFAS, and when properly used by trained personnel, they will help protect workers. However, the indispensable D element must be in place for the PFAS to function as intended. The D stands for descent, rescue, and retrieval. It is included because fallen workers may find it difficult, if not impossible, to reach safety without assistance. To rely solely on a local emergency medical services (EMS) response team for assistance may put workers' lives in danger.

The rescue and retrieval of a fallen worker is a complex and inherently dangerous operation that requires courage, determination, skill, and above all, proper training. Having a clearly defined rescue plan in place before any work is done at height is of utmost importance. The plan must include adequate training of personnel assigned to rescue and retrieval teams, and crews must be available to respond promptly whenever a fall occurs. The fall protection plans developed by employers or contractors should include the rescue and retrieval of a fallen worker.

A variety of techniques can be used to rescue fallen workers. Some are more complex and dangerous than others. In most instances, as the complexity of the rescue increases, so do the risks. As a result, the techniques available should be considered in the hierarchy from least to most complex, as discussed below.

FIGURE 22
Assisted self-rescue

Self-Rescue Ideally, fallen workers can climb or pull themselves to safety with little or no assistance from others. When this is possible, it is usually the quickest and safest option. Figure 21 shows a worker performing self-rescue after a fall.

Assisted Self-Rescue In some cases, a fallen worker can use the self-rescue technique only with the assistance of someone else, such as bringing a ladder and ensuring it is positioned properly. Figure 22 shows a crew member assisting a fallen coworker by providing access to a ladder. Whenever this approach is taken, the assisting worker must remain nearby to make sure the fallen worker reaches safety without incident, is uninjured, and needs no further help.

Mechanically Aided Rescue When self-rescue or assisted self-rescue are impractical, it may be possible to use a lift or bucket truck to rescue a fallen worker. This may not be a good option for rescues carried out in large

TRADE TIP

It is important to ensure the rescue team understands suspension trauma, as some emergency medical services may not be trained in its treatment.

work areas since moving and positioning the required equipment could take too much time. The longer the rescue takes, the more dangerous it becomes for the fallen worker. One reason for this is the likelihood the fallen worker will develop **suspension trauma**, which is an effect that occurs when the human body is held upright without any movement for a period of time. This will be described in more detail later in this chapter. A mechanically aided rescue is shown in Figure 23.

Rescue Pick-Offs Rescue pick-offs involve a variety of techniques used to rescue injured or otherwise incapacitated workers. It involves hoisting victims safely from one level to another with the use of ropes, pulleys, harnesses, and other equipment designed specifically for rescue. There are also rigging systems that can be built on-site or manufactured and that are designed either to raise or lower fallen workers for safe extraction.

FIGURE 23
Mechanically aided rescue

SELF CHECK

1. Explain the difference between a certified and noncertified anchorage.
2. What is an anchorage point?
3. Explain what a full-body harness is and describe how it is used to protect a worker from fall-related injuries.
4. What is a connector and how does it function as part of a personal fall protection system?
5. Describe four types of rescue.

2 Fall Restraint

A personal fall restraint system minimizes the risk of a fall or fall-related injury by preventing a worker from reaching an unprotected edge. The system consists of an anchorage, connectors, and full-body harness, as shown in Figure 24. As with a PFAS, a personal fall restraint system must be properly used in order to work as intended and provide the required protection.

Personal fall restraint system connectors can be attached to D-rings located at the front, back, or side of the full-body harness. Figure 25 shows a connector attached to the back D-ring. Connectors must be attached to an anchorage that is capable of supporting at least 3,000 pounds or more, depending on the potential impact load of a worker's fall. All system snap hooks and D-rings must be proof-tested to a minimum load of 3,600 pounds without deforming or breaking.

FIGURE 24
Personal fall restraint system

FIGURE 25
Attached connector

Positioning Device System

A **positioning device** is a body belt or body harness system that allows a worker to work hands-free and to be supported on an elevated vertical surface. The system consists of a body belt or body harness rigged to support a leaning worker positioned on an elevated vertical surface such as a wall, as shown in Figure 26. To function as intended, the system must be properly used. Harnesses must have side D-rings or a single front D-ring for positioning. The system must be able to stop a free fall within 2′-0″. Some regulatory agencies, such as the United States Army Corps of Engineers (USACE), require a worker using a positioning device system to have a separate backup safety system to protect against falls.

FIGURE 26
Positioning device system

SAFETY TIP

A body belt should never be used as part of a personal fall arrest system. Body belts should be used only with positioning harnesses or for fall restraint.

SELF CHECK

1. When would a fall restraint system be used?
2. Describe where and when a positioning device system would be used.

3 Fall Arrest Lanyards and Lifelines

As described previously, a fall arrest system consists of an anchorage, connectors, and a full-body harness in conjunction with a descent and rescue plan and designated rescue team that has been properly trained and is ready to execute it promptly and safely. Rescue teams regularly practice their training to improve response time and efficiency, and to test the latest technology. All parts of a fall arrest system must work together to decelerate and stop a falling worker, minimize swing fall and the arresting force imposed on the worker's body, and facilitate a prompt rescue. While all parts of the fall arrest system are necessary and none are dispensable, the key element is the personal fall arrest system (PFAS), consisting of a lanyard, lifeline, or other connecting device that links the anchorage to the body harness and supports the fallen worker until rescue is possible.

SAFETY TIP

Lanyards and vertical lifelines must have a minimal breaking strength of 5,000 pounds.

What Is a Lanyard?

A **lanyard** is a flexible length of fiber rope, wire rope, or strap that can be securely attached to a body harness, lifeline, or anchorage. The lanyard may include an integral deceleration device or a deceleration device may be added to the lanyard. A **deceleration device** is a mechanism designed to slow a falling worker and dissipate or limit the kinetic energy imposed on the worker during a fall arrest; this is also known as a shock-absorbing device. All lanyards are equipped with locking snap hooks, carabiners, or similar hardware at either end to facilitate attachment to other fall protection or rescue components. Once a lanyard with a deceleration device has been used to arrest a fall or the shock absorber has been deployed, it is no longer trustworthy. The competent person should be notified and the lanyard removed from service immediately and destroyed to make sure it is not reused.

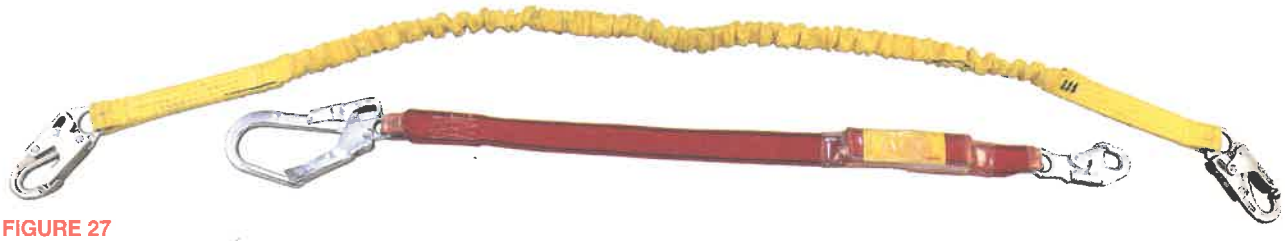


FIGURE 27
Shorter and longer lanyards

SAFETY TIP

A lanyard should never be tied in a knot to reduce its length, as this may reduce its strength by half and endanger a worker depending on it for support.

Lanyard Length Lanyards are available in a wide variety of lengths and styles to fit differing circumstances. The most common lengths of lanyards are 4′-0″ and 6′-0″. See Figure 27. The length of the lanyard is a particularly important consideration since it should be long enough for easy use while still being short enough to minimize free-fall distance.

Webbing Lanyard webbing must be strong enough to endure hard use and exposure to sunlight and harsh weather without tearing or fraying. Some lanyard applications may require fire-resistant webbing or extra protection against arc flash hazards. Webbing may also be coated with polyurethane to resist grease, oil, dirt, and grime.

FIGURE 28
Cable lanyard

Cable Some lanyards are made of vinyl-covered cable for extra durability or for use in high-heat environments. A cable lanyard is shown in Figure 28.

Deceleration/Shock-Absorbing Devices

A deceleration device, also known as a shock-absorbing device, is a mechanism designed to slow a falling worker and dissipate or limit the kinetic energy imposed on the worker during a fall arrest. Some lanyards have built-in deceleration devices, such as pack-style, deformed, and rip-stitch lanyards. When the pack-style lanyard is engaged as a result of a fall, the material will slowly tear from the pack and reduce the forces imposed on the body. The deforming lanyard is an elastic lanyard that will stretch slightly to allow a slight amount of extra movement for the worker. When a fall occurs, the lanyard will stretch, rip, and deform from its original design, slowing the fall. The specialized stitching of a rip-stitch lanyard tears as the lanyard extends in order to dissipate the energy of the fall. Figure 29 shows a variety of lanyards with integral deceleration devices.

SAFETY TIP

After a fall, all parts of the PFAS system must be inspected and recertified or removed from service.

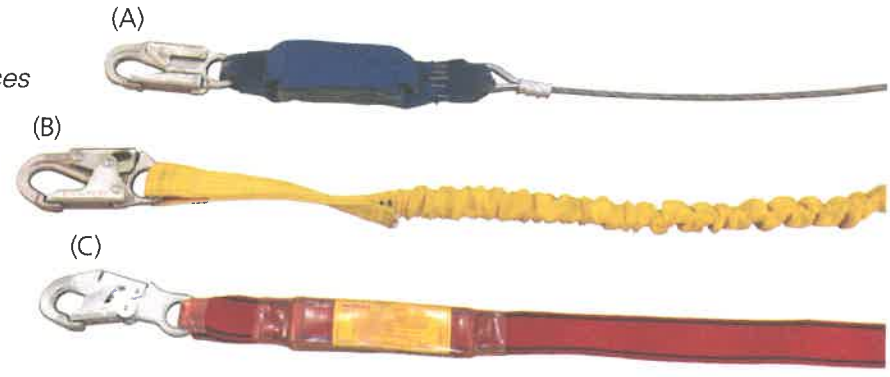


FIGURE 29
Lanyards with deceleration devices
(A) Pack-style lanyard
(B) Deformed lanyard
(C) Rip-stitch lanyard

When falling, a worker will accelerate until the deceleration device is activated at the end of the free fall. After activation, the energy of the fall will dissipate until the worker comes to a full stop. The distance between the activation point and the full stop is referred to as the deceleration distance; this distance cannot exceed 3′-6″. Figure 30 shows a deployed deceleration device.

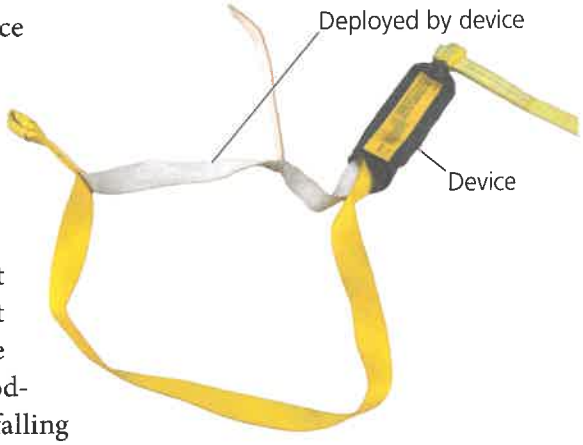


FIGURE 30
Deployed deceleration device

Lanyards designed for use in a personal fall arrest system must contain a shock-absorbing unit capable of limiting the impact forces placed on a worker to 1,800 pounds, with up to 6′-0″of free fall. Lanyards produced by most manufacturers incorporate products that assist in ensuring that the arresting forces imposed on falling workers are kept below 900 pounds.

Twin-Legged Lanyards

Because of its versatility, the twin-legged lanyard, also known as a 100 percent tie-off lanyard, continues to increase in popularity among safety experts and construction professionals. See Figure 31. The legs of the lanyard are attached to a shock absorber and snap hook, which allows the worker to move horizontally from one area to another while remaining continuously attached. Additional advantages provided by this configuration include the following:

- provides the convenience of a one-piece device with easy handling
- requires only one shock absorber for both legs
- allows the worker to bypass obstructions while remaining attached
- avoids the need to attach two separate lanyard snap hooks to a single harness D-ring
- when not in use, the second leg can be stowed away to avoid dragging or hanging

FIGURE 31
Using a twin-legged lanyard

As with any fall safety device, the use of a twin-legged lanyard requires special care. For instance, only one leg can be attached at a time. If both hooks are used at the same time, the shock absorber will not deploy properly. When a twin-legged lanyard is used, the first leg should be unhooked as soon as the second is hooked, and so on. Other tips for the safe use of twin-legged lanyards include the following:

- The snap hook on the lanyard stem should always be attached to the harness or D-ring.
- Workers must not attempt to extend the lanyard's reach by attaching one leg to the harness and the other to the anchorage point, as this will result in greater fall distances and could possibly lead to a serious or fatal injury.
- The leg of the lanyard that is not in use should be connected to one of the manufacturer-approved harness attachment points. This unused leg should not be attached to the harness D-rings because it may add to body load during a fall.

FALL AWARENESS SCENARIO

A high-steel rigger fell to his death at a sports arena in San Antonio, Texas while dismantling a show at 2:00 a.m. Witnesses said he had detached himself from the fall safety line while repositioning himself and lost his footing while moving around a beam. Due to the fatigue factor, late work of this type can be very dangerous and workers may not be thinking clearly or fully aware of their surroundings. It is likely that fatigue played a significant role in this fatal accident. Tragically, the deceased worker, aged 44, left behind a wife and a 3-month-old daughter.

- How could this accident have been avoided?

Other Types of Lanyards

Although double tie-off lanyards have significant advantages, many other types of lanyard are available and are commonly used in construction. These include various types of specialty shock-absorbing lanyards, positioning lanyards, adjustable lanyards, and stretch lanyards. The choice of lanyard will depend on availability, the requirements of the job, and circumstances at the jobsite.

Tie-Back Lanyards When an anchorage connector is not available, a tie-back lanyard can serve as both a means of connection and an anchorage connector. Tie-back lanyards are available in two styles. One style incorporates an adjustable D-ring for attaching locking snap hooks and one locks back into the webbing itself, as shown in Figure 32. Tie-back lanyards used

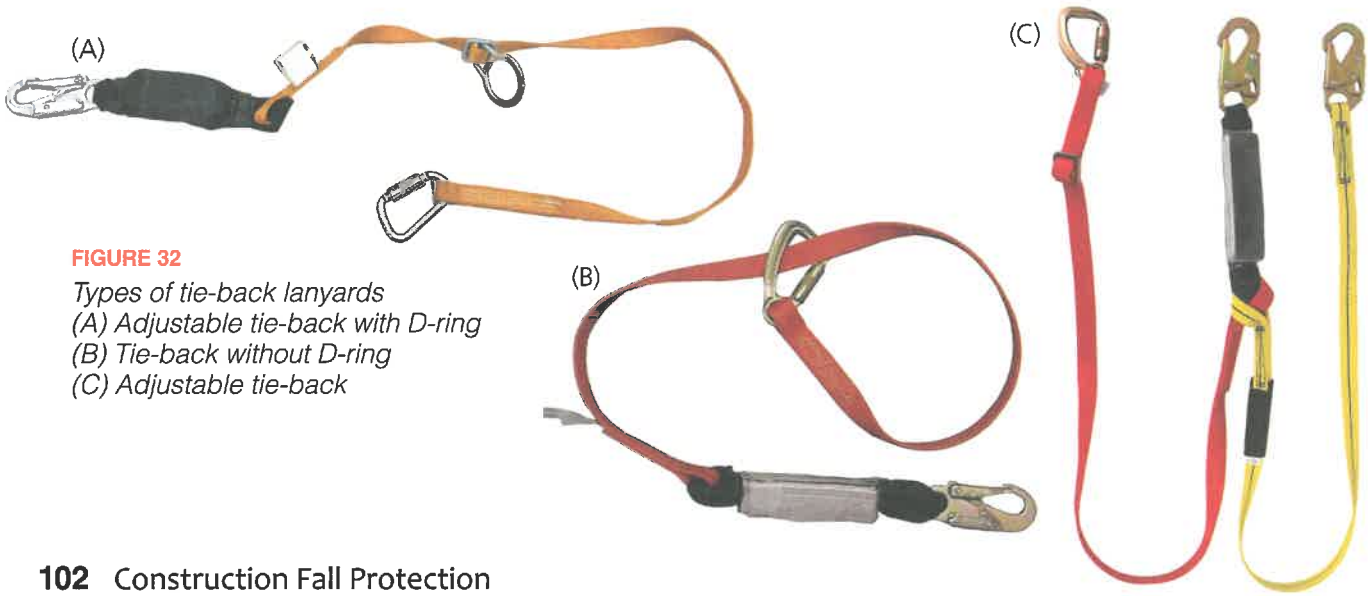


FIGURE 32
Types of tie-back lanyards
(A) Adjustable tie-back with D-ring
(B) Tie-back without D-ring
(C) Adjustable tie-back

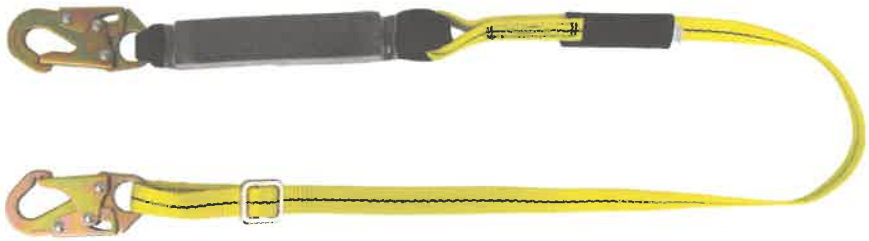
in this way must be specifically manufactured for this purpose and must be properly labeled.

Shock-Absorbing Stretch Lanyards For added flexibility and safety, stretch lanyards, also called deforming lanyards by the manufacturers, are available with an expansion and contraction feature. This allows them to be extended to provide additional length when needed, and can then contract with the movement of the worker. This feature can also help avoid trips, falls, and snags. A stretch lanyard is shown in Figure 33.

FIGURE 33
Stretch lanyard

Adjustable Lanyards Adjustable lanyards offer the convenience of adjustability and can be especially useful in situations where precise lanyard length is critical. Length can be modified with the use of a built-in adjuster that slides up and down the length of the lanyard, as shown in Figure 34.

FIGURE 34
Adjustable lanyard



Self-Retracting Devices (SRDs)

Some PFAS equipment will have a **self-retracting device (SRD)**, a retractable lanyard that relies on *inertia* to activate a braking mechanism housed in a specially designed block. In this case, inertia means that when a certain level of speed or force has been achieved a locking mechanism will engage. These devices are also known as fall limiters, personal fall limiters, yo-yos, or self-retracting lanyards (SRLs). SRDs feature an automatically spooling reel attached to an anchorage at one end. At the other end is a lifeline attached directly to the worker's harness. SRDs work in much the same way as a seat belt in an automobile. Impact indicators are built into the SRD to show whether the shock absorber has been deployed. Figure 35 shows an impact indicator.

FIGURE 35
Impact indicator

SRDs commonly used on construction sites include the following:

- self-retracting lanyards (SRLs)
- self-retracting lanyards-leading edge (SRL-LEs)
- self-retracting lanyards-rescue (SRL-Rs)

Self-Retracting Lanyard (SRL) SRLs that limit free-fall distance to 24″ or less with a maximum arresting force of 1,350 pounds are referred to as Class A. Class A SRLs should be used only when the tie-off is overhead, the free fall is limited to 24″ or less, and there is no possibility of a fall from a leading edge. A Class A SRL is shown in Figure 36. Class B SRLs should be used for all other applications. SRLs that have a maximum free-fall distance of 54″ and a maximum arresting force of 900 pounds are designated as Class B. Class B SRLs can be manufactured from 3′-0″ to 175′-0″ in length. A Class B SRL is shown in Figure 37.

FIGURE 36
Class A SRL

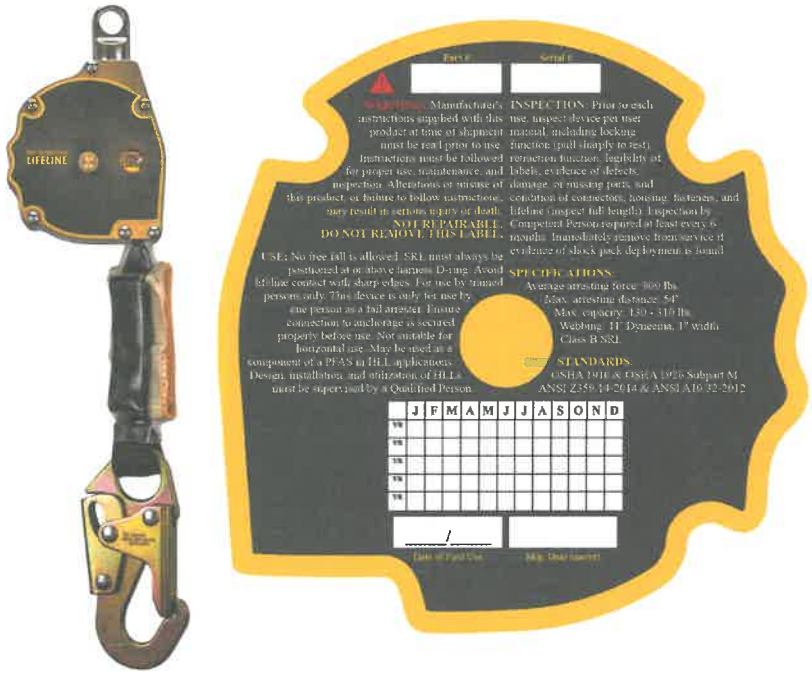


FIGURE 37
Class B SRL

FIGURE 38
SRL-LE anchored at foot level

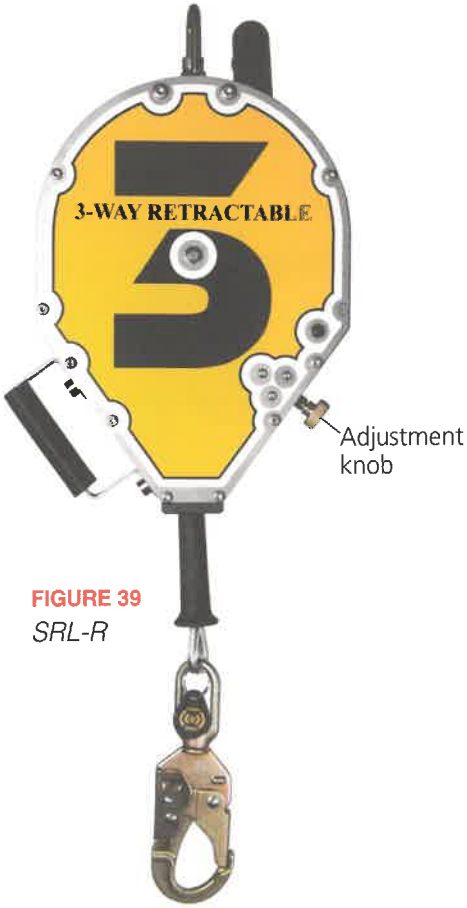


FIGURE 39
SRL-R

Self-Retracting Lanyard-Leading Edge (SRL-LE) An SRL-LE is a Class B self-retracting lanyard that incorporates a wire rope that will resist damage when pulled over a sharp or abrasive edge during a fall. These lanyards may be recommended when overhead anchorage is unavailable. An SRL-LE may be anchored at foot level, as shown in Figure 38, and used whenever the possible free fall is 5′-0″ or less. Webbed SRDs cannot be used for a leading edge; wire rope must be used. Some manufacturers may produce what is known as a sharp-edge SRL. These SRLs are tested for breaking against sharp edges with a radius of no more than .005″.

Self-Retracting Lanyard-Rescue (SRL-R) SRL-Rs are self-retracting lanyards with a self-rescue capability. Some SRLs have a rescue/automatic descent component built into their housing. With this style of SRL, the user can choose one of two options by using the adjustment knob located on the housing. The device can be set so that it will arrest the fall and stay locked until the weight of the worker is relieved, or it can be set to arrest the fall and then automatically lower the worker to the next available walking surface. Figure 39 shows one style of an SRL-R.

Vertical Lifelines

A **vertical lifeline** is a flexible length of rope or wire rope that connects to an anchor point at one end and is to be used with a rope grab along its length. Vertical lifelines typically consist of either a synthetic fiber or wire rope. The rope attaches to an overhead anchorage and must be connected directly to a worker's full-body harness, lanyard, or rope grab. Figure 40 shows a worker using a rope grab on a vertical lifeline. Only one person can be attached to each vertical lifeline.

FIGURE 40
Using a vertical lifeline with a rope grab

FIGURE 41
Rope grab

Vertical lifelines must have a breaking strength of 5,000 pounds or more. Breaking strength is the amount of force needed to tear a lanyard or lifeline apart. These are meant to be used by a worker that must go up and down to complete a task, as opposed to a horizontal lifeline where the worker will remain on the same level.

When using a vertical lifeline, a worker should keep horizontal movement to a minimum. This is done to avoid the risk of swing fall, the dangerous pendulum motion that can result when a worker swings back under the anchor point. Excessive swing fall may cause serious injury if a worker strikes a wall or other obstacle. The farther a worker moves out of vertical alignment with the overhead anchorage point of the lifeline, the greater the likelihood of swing fall.

Rope Grabs

Intended for use with vertical lifelines, rope grabs are designed to slide easily during a climb and then lock tightly during a fall. See Figure 41. Rope grabs feature a cam or lever that will engage a knurled surface against the rope and lock tightly during a fall. A knurled surface has small ridges, called knurls, on the surface that are used for gripping. Rope grabs are designed for use with rope of a specific diameter. The appropriate rope diameter will be printed or stamped on the side of the rope grab. Rope grabs may be manufactured with or without a permanently attached lanyard. Whether the rope grab used is manufactured with or without a lanyard, the lanyard length cannot exceed 3′-0″. The manufacturer's instructions must be carefully followed when attaching a rope grab to a vertical lifeline. When working while attached to a vertical lifeline, the rope grab should be adjusted as high as possible on the lifeline to reduce the distance of a fall, should one occur.

Horizontal Lifelines

A **horizontal lifeline** consists of synthetic fiber rope, wire rope, or a rail system attached between two anchor points. An example of a horizontal lifeline is shown in Figure 42. The primary advantage of a horizontal lifeline is that a connected worker can move horizontally, minimizing the risk of a swing fall. However, if a horizontal lifeline has not been installed correctly it may fail at the anchorage points. To help ensure that this does not happen, horizontal lifelines must be designed, installed, and used under the supervision of a qualified person.

A load placed on a horizontal lifeline will cause it to deflect, or sag, as shown in Figure 43. Over-tightening the lifeline to avoid this is not recommended, as this could dramatically increase the forces exerted on the line during a fall, especially at impact. Workers must refer to the manufacturer's specifications during installation of the system.

Swing Fall

When attached to lifelines, construction professionals working at height should be aware of their position relative to the lifeline anchorage point.

FIGURE 42
Horizontal lifeline

FIGURE 43
Horizontal lifeline deflection

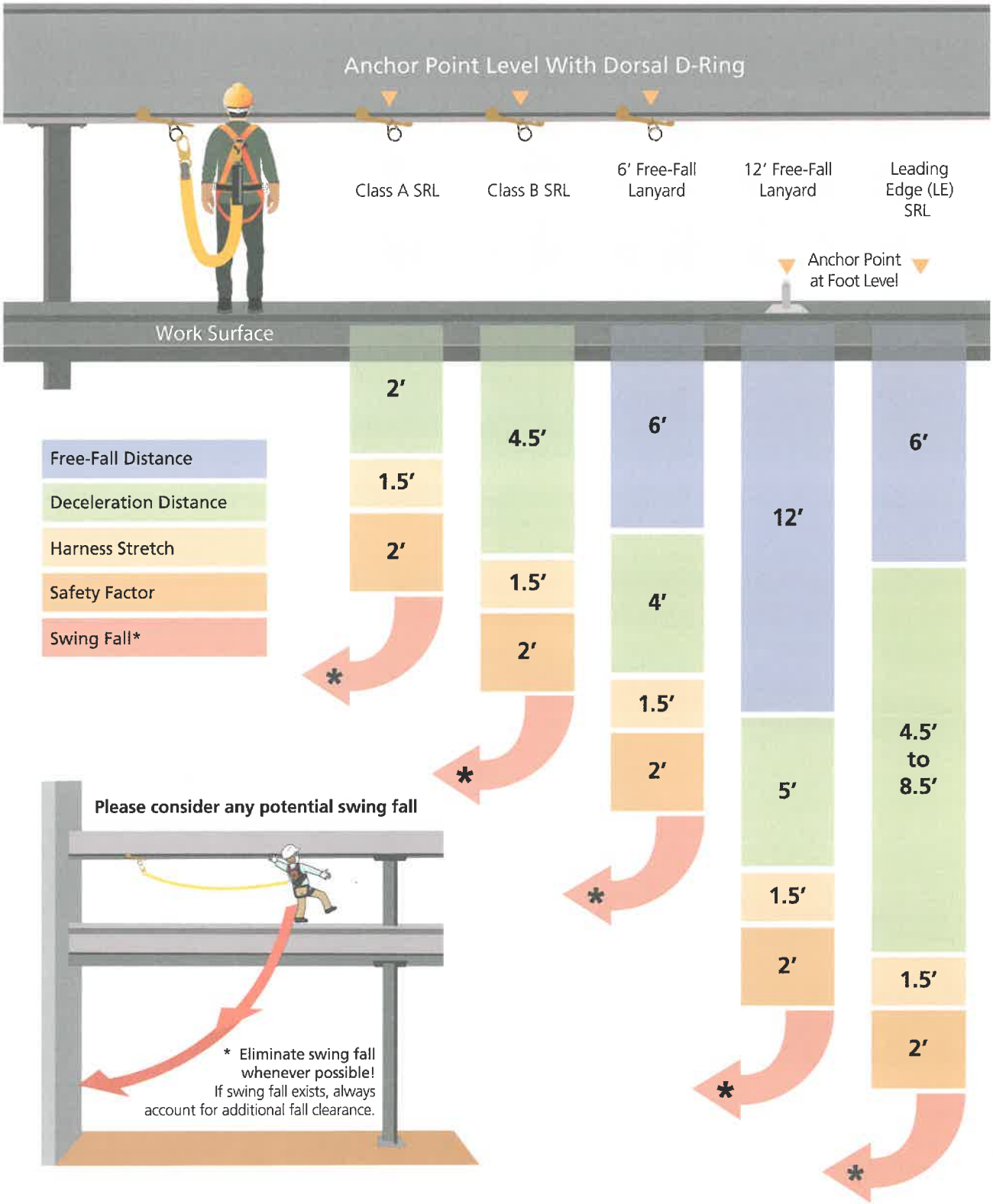
Lanyards should be connected at or above the shoulder of the user to minimize fall distance. Once properly connected, workers should not walk too far away from an overhead anchorage, because this will increase the risk

of a dangerous swing fall. The working distance chart in Figure 44 shows working distance limits recommended to avoid a swing fall. Swing falls are hazardous because the pendulum motion can increase the risk of hitting a wall or other solid object at a lower level.

FIGURE 44

Working distance chart

Fall clearance calculation shown based on standing worker falling directly in line with anchor point. Always consider potential swing fall and other hazards when calculating fall clearance.



SELF CHECK

1. What is a lanyard and why does the length of the lanyard matter?
2. Describe four common types of lanyard.
3. What is a deceleration device and how does it help protect a falling worker from injury?
4. Explain how vertical lifelines are used as part of a PFAS.
5. Describe how a rope grab works.
6. Describe how horizontal lifelines are used as part of a PFAS.
7. Describe the dangers of a swing fall.

4 Descent and Rescue

No matter how well equipped or trained workers may be, falls will occur. When they do, supervisors and fellow workers not directly affected by the accident must act immediately. To ensure the worker reaches safety as quickly as possible, the employer must have an adequate descent, rescue, and retrieval plan, as well as trained personnel who are able to properly execute it. Rescue planning and training must take into consideration the wide variety of circumstances rescue teams may face, including the need to carry out the rescue in a confined space or the possibility that the fallen worker may have been injured or may be suffering from suspension trauma. Suspension trauma can occur when the human body is held upright without any movement for a period of time. Figure 45 shows a well-trained team rescuing a fallen worker.

SAFETY TIP

Prompt rescues save lives.

FIGURE 45
Rescue in progress

FIGURE 46
Personnel attending a training session

Importance of Preparedness

The proper response to any emergency will depend heavily on adequate preparation. A fall or any other emergency can be an unexpected and emotionally trying event. When faced with such a situation, it is far easier to remain calm and do the right thing when the appropriate response has been carefully planned out well in advance. Proper preparation for a fall or other construction site emergency will require thorough training and a well-organized emergency response plan.

Training All project personnel must attend a site-specific safety training session where emergency response procedures will be reviewed and instruction regarding alarms, assembly areas, and any rescue activities required by the employer will be given. In most cases, a specially designated crew will be thoroughly trained to safely and effectively carry out rescue operations. Each member of the crew must know where all rescue equipment is located and how to use it properly. Rescue crews should review the required procedures at least once every two weeks. The operators of cranes, lifts, and other mobile rescue equipment should be included in the review. Figure 46 shows construction site personnel attending a training session.

SAFETY TIP

Review and update the fall protection plan as the job progresses and anytime a fall has taken place.

Importance of a Prompt Response

When a worker has fallen and becomes suspended in a body harness, immediate action must be taken to rescue the worker before the incident can lead to further harm. Workers who have fallen must remain calm until rescued, which may not be easy to do when hanging from a lifeline far above the ground or floor. The victim will want a prompt rescue in order to return to safety as soon as possible. Additional reasons for a prompt rescue include the following:

- The worker may have suffered injuries during the fall and may need immediate medical attention.
- When workers are suspended in their safety harnesses for periods over five minutes, they may suffer from blood pooling in the lower body, which can lead to severe suspension trauma.
- Suspended workers may panic if they are not rescued quickly.
- The event that led to the fall may create additional risks that must be addressed to avoid additional accidents and injuries.

Emergency Response Plan

When a worker has fallen and is suspended in a safety harness, the jobsite emergency response plan will be initiated immediately. The site plan should be prepared and formalized by the employer before any work is done at elevation. If not, the lives of workers could be put in danger. The plan should outline the steps that must be taken: (1) after the accident has happened, but before the rescue gets underway; (2) during the rescue operation itself;

and (3) after the rescue has been safely completed. Properly trained workers should fully understand each phase of the plan and the roles they will be expected to play in them. The following sample emergency response plan reveals how one construction company has planned to handle falls or similar emergencies.

SAMPLE EMERGENCY RESPONSE PLAN

Statement of Purpose

The implementation and maintenance of a safe work environment is the collective responsibility of all employees, contractors, and visitors to the jobsite. It is our company policy to provide prompt medical treatment when a worker is injured on the jobsite. To do this, workers may have to perform a working-at-heights rescue to bring down a worker who has fallen and is suspended in a safety harness. This procedure applies to all managers, supervisors, forepersons, employees, subcontractors, and visitors of _____ _____ jobsite.

Working-at-Heights Rescues

When a worker falls and is suspended in a harness, it is important to rescue him or her as quickly as possible for the following reasons.

- The worker may have suffered injuries during the fall and may need medical attention.
- When workers are suspended in their safety harnesses for long periods, they may suffer from blood pooling in the lower body. This can lead to suspension trauma.
- Suspended workers may panic if they are not rescued quickly.
- The event that led to the fall may create additional risks that need to be addressed.

Training

All site personnel must attend a site-specific safety training session where they will review emergency response procedures and receive instruction on alarms and assembly areas.

A designated crew will be trained to perform the rescue. This crew must know how to use the equipment that is available to them at the jobsite and where they can find it. Crew members should review the rescue procedure every two weeks with the crane crews.

Emergency Response Plan

If a worker falls and is suspended by a safety harness, the emergency response plan is implemented by following the steps below. Note: It is important that all workers know their role.

1. The site supervisor or alternate foreperson takes control of the situation.
2. The site supervisor alerts all workers in the immediate vicinity of the incident to stop working.

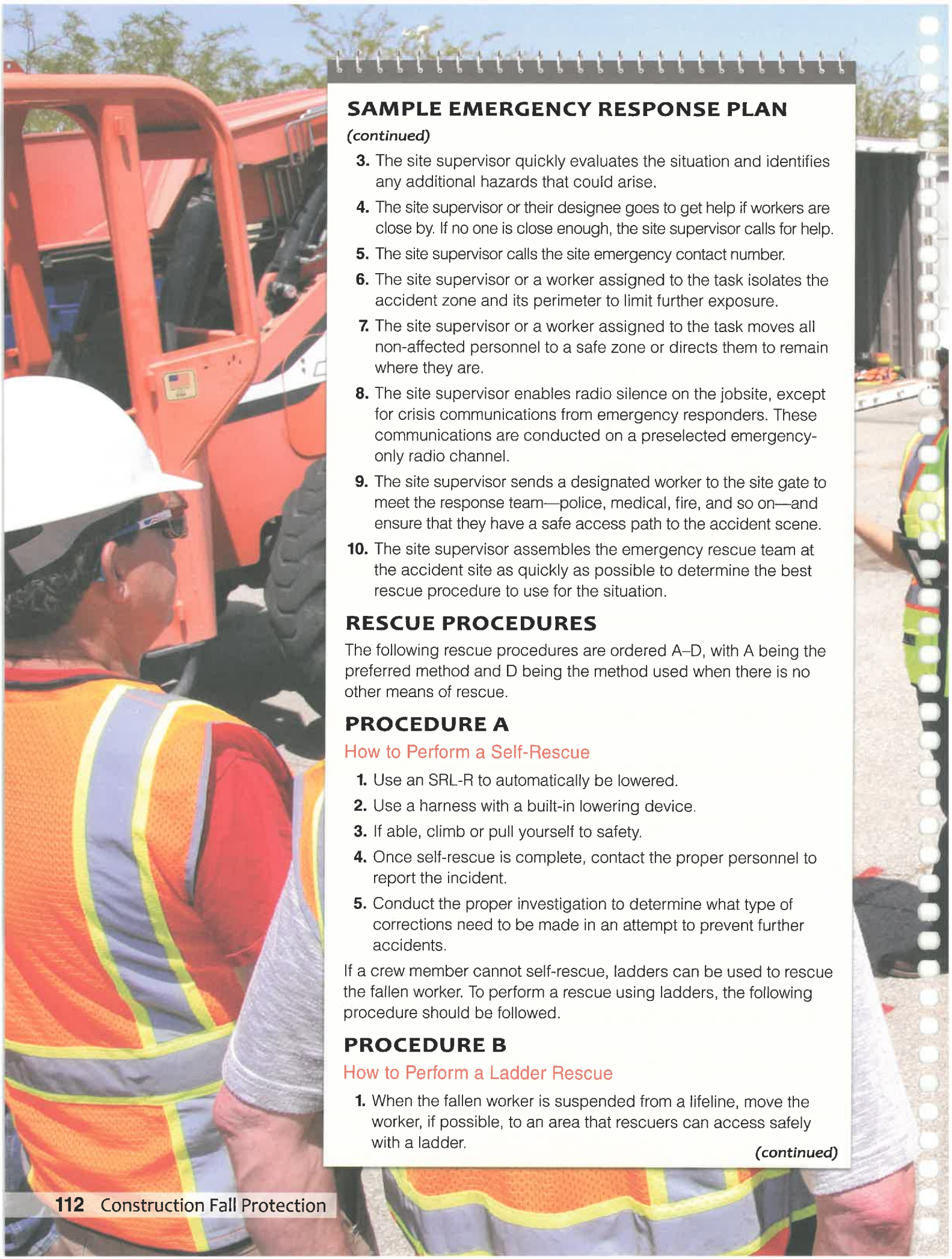
(continued)

SAFETY TIP

Only trained rescue personnel should handle a suspended worker who has lost consciousness. Doing so without training can cause more injury to the worker.

SAFETY TIP

The importance of knowing the correct jobsite emergency number will ensure the proper response crew is contacted. 911 may not be the proper emergency contact number.



SAMPLE EMERGENCY RESPONSE PLAN

(continued)

3. The site supervisor quickly evaluates the situation and identifies any additional hazards that could arise.
4. The site supervisor or their designee goes to get help if workers are close by. If no one is close enough, the site supervisor calls for help.
5. The site supervisor calls the site emergency contact number.
6. The site supervisor or a worker assigned to the task isolates the accident zone and its perimeter to limit further exposure.
7. The site supervisor or a worker assigned to the task moves all non-affected personnel to a safe zone or directs them to remain where they are.
8. The site supervisor enables radio silence on the jobsite, except for crisis communications from emergency responders. These communications are conducted on a preselected emergency-only radio channel.
9. The site supervisor sends a designated worker to the site gate to meet the response team—police, medical, fire, and so on—and ensure that they have a safe access path to the accident scene.
10. The site supervisor assembles the emergency rescue team at the accident site as quickly as possible to determine the best rescue procedure to use for the situation.

RESCUE PROCEDURES

The following rescue procedures are ordered A–D, with A being the preferred method and D being the method used when there is no other means of rescue.

PROCEDURE A

How to Perform a Self-Rescue

1. Use an SRL-R to automatically be lowered.
2. Use a harness with a built-in lowering device.
3. If able, climb or pull yourself to safety.
4. Once self-rescue is complete, contact the proper personnel to report the incident.
5. Conduct the proper investigation to determine what type of corrections need to be made in an attempt to prevent further accidents.

If a crew member cannot self-rescue, ladders can be used to rescue the fallen worker. To perform a rescue using ladders, the following procedure should be followed.

PROCEDURE B

How to Perform a Ladder Rescue

1. When the fallen worker is suspended from a lifeline, move the worker, if possible, to an area that rescuers can access safely with a ladder.

(continued)

PROCEDURE B *(continued)*

2. Set up the appropriate ladder or ladders to reach the fallen worker.
3. Rig separate lifelines for rescuers to use while carrying out the rescue from the ladder(s).
4. If the fallen worker is not conscious or cannot reliably help with the rescue, a minimum of two rescuers may be needed.
5. If the fallen worker is suspended directly from a lanyard or a lifeline, securely attach a separate lowering line to the harness.
6. Other rescuers on the ground or the closest work surface should lower the fallen worker while the rescuer on the ladder guides the fallen worker to the ground or work surface.
7. Once the fallen worker has been taken to a safe location, administer first aid and treat the person for suspension trauma and any other injuries.
8. Arrange transportation to a hospital, if required.

The following procedure should be followed if there is a mobile elevating work platform (MEWP) on-site and the suspended worker can be reached by the platform.

PROCEDURE C

How to Perform a Mobile Elevating Work Platform Rescue

1. Bring the MEWP to the accident site and use it to reach the suspended worker.
2. Ensure that rescue workers are wearing full-body harnesses attached to appropriate anchors on the MEWP.
3. Ensure that the MEWP has the load capacity for both the rescuers and the fallen worker. If the fallen worker is not conscious, two rescuers will probably be needed to safely handle the weight of the fallen worker.
4. Position the MEWP platform below the worker and disconnect the worker's lanyard when it is safe to do so. Once the worker is safely aboard the MEWP, reattach the lanyard to an appropriate anchor point on the MEWP, if possible.
5. Lower the worker to a safe location and administer first aid. Treat the worker for suspension trauma and any other injuries.
6. Arrange transportation to a hospital, if required.

If the fallen worker is suspended near a work area and can be safely reached from the floor below or from the area from which the fall occurred, the following procedure should be followed.

PROCEDURE D

How to Perform a Rescue From a Work Area or the Floor Below

1. Ensure that rescuers are protected against falling.

(continued)

PROCEDURE D *(continued)*

2. If possible, securely attach a second line to the fallen worker's harness to help rescuers pull the fallen worker to a safe area. You will need at least two strong workers to pull someone up to the level from which they fell.
3. Take up any slack in the retrieving line to avoid slippage.
4. Once the worker has been brought to a safe location, administer first aid and treat the person for suspension trauma and any other injury.
5. Arrange transportation to hospital if required.

All non-affected workers should remain in the designated safe gathering zone until the site supervisor has notified them to do otherwise. An accident investigation should be conducted once the rescue has been completed.

SAFETY TIP

Working in a confined space can be hazardous. No person should ever enter a confined space without the proper training.

TRADE TIP

Tripods can be set up by one worker and easily transported from one location to another.

TRADE TIP

Treat all confined spaces as hazardous. Do not enter a space until the air has been tested for oxygen, flammable vapors, and toxic chemicals.

Confined Space Rescues

It may be necessary for construction professionals to work in or near confined spaces where little room is available for performing required tasks or carrying out fall rescues. A confined space is an area with limited or restricted means of entry and exit, not designed for continuous employee occupancy, which is large enough and configured so that an employee can bodily enter it and perform the assigned work. Falls can occur within or into confined spaces, and rescue teams must be prepared to carry out rescue and retrieval operations safely and efficiently. It is the employer's responsibility to ensure that all confined space rescuers have been properly trained. These rescue operations may be complicated by the limited or restricted means of entry and exit, limited space for carrying out rescue procedures, and the unsuitability of such spaces for continuous human occupancy. In many cases, a confined space rescue will require the following specialized equipment and rescue techniques.

Self-Retracting Lifelines A self-retracting lifeline is a deceleration device containing a drum-wound line that can be slowly extracted from or retracted onto the drum under slight tension during normal worker movement. After the onset of a fall, the drum will automatically lock and arrest the fall within 2-0″. Self-retracting lifelines are available in varying lengths and cable materials. The most common is a galvanized cable of 30′-0″ to 50′-0″. These lifelines can be integrated with a retrieval system that incorporates the use of a tripod, davit arm, or overhead anchor point for confined space entry situations.

When these lifelines are used with a tripod or davit arm, the drum of a self-retracting lifeline will be attached to the leg of a tripod or the post of a davit arm. The cable will run through a pulley located at the center of the tripod or

tip of the davit arm. In order to comply with OSHA, the system must allow for descent, be useable as fall arrest, and be capable of being used for retrieval. When used together, these systems will allow trained personnel to perform a non-entry rescue when necessary. Figure 47 shows a tripod used in fall rescue operations.

Davit Arm If more versatility is required than can be provided by a tripod, a *davit arm* may be a good option. A davit arm is shown in Figure 48. Davits have a variety of base configurations, one or more of which may prove ideal for a job or rescue operations. Some davits have adjustable bases that can be used to hoist fallen workers over large openings. Others are fixed in a V-shape and can be placed adjacent to the opening. Both portable and fixed-position bases are available for davit systems and can be used in conjunction with self-retracting lifelines.

FIGURE 47
Tripod used for rescue

FIGURE 48
Davit arm

FIGURE 49
Winch rescue

Winches A winch, including a steel or synthetic line with a crank to release or rewind the line, can be connected to a tripod or davit system to raise, lower, or extract a fallen worker. The benefits of using a winch include mechanical advantage, which will allow a single worker to easily lower, lift, or extract the fallen worker, and a secure braking system. Should the winch operator let go of the crank, the person who is being raised or lowered will not be dropped. A power drive is an optional feature on some winches that makes frequent raising and lowering easier. Winches are often used for horizontal rescues, such as those that must be made through the side of a tank. Figure 49 shows a winch being used to rescue a worker from a confined space.

Specialized Harnesses When using a winch to rescue a fallen worker from a confined space, a specialized harness with D-rings on the top of both shoulder straps may be required. A specialized harness of this type is shown in Figure 50. A twin-legged lanyard can be connected to these D-rings so the victim of the fall, who may be injured, can be raised and lowered in a fully vertical position.

FIGURE 50
Specialized harness

SAFETY TIP

Suspended workers should try to move their legs in the harness and try to push against any footholds, such as trauma straps.

FALL AWARENESS SCENARIO

Four construction professionals were working in an inactive sewer system on a jobsite that had been unoccupied for over a week. A few minutes after they started working, the crew noticed the foreman was missing and a manhole cover had been removed. While one worker called emergency services, a second worker entered the manhole to assist the foreman and found him unresponsive at the bottom of the 20′-0″-deep manhole. When the second worker became disoriented inside the manhole, another worker used a fan to blow fresh air into the manhole and the worker was able to climb out. The foreman was retrieved by fire department personnel and was later pronounced dead due to asphyxiation.

- How could this incident have been prevented?
- Have you ever known anyone who experienced a similar incident?

5 Suspension Trauma

After a worker has fallen and has been caught by a fall protection harness, the threat to the worker's health is far from over. The worker still must be safely rescued without the risk of an additional fall or similar accident. In addition, the rescue must be carried out promptly, or the fallen worker may be afflicted by a condition known as suspension trauma. Suspension trauma, also known as orthostatic intolerance, can lead to serious injury and can be fatal in extreme cases. Figure 51 shows a worker suspended in a harness and who may be vulnerable to suspension trauma.

FIGURE 51
Vulnerable worker

SAFETY TIP

If a fall occurs, it may be possible to provide a ladder, MEWP, or some other equipment for a worker to stand on.

What Is Suspension Trauma?

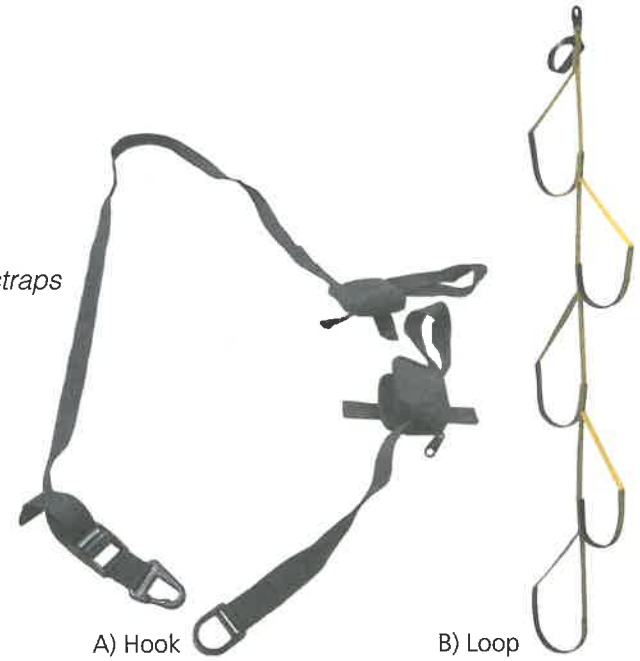
Suspension trauma may occur when a worker experiences a fall and remains suspended in the fall arrest harness. While suspended, lack of movement, along with the leg straps applying pressure to the femoral arteries, reduces blood flow. As a result, the body will speed up the heart rate to increase blood flow to the brain. In such cases where the blood supply is insufficient, an increased heart rate will not effectively increase blood flow to the brain. Consequently, the brain will cause the body to dramatically reduce the heart rate, which causes the blood pressure to decrease. A lack of blood pressure and circulation to the brain will produce a fainting response. This can be observed when a soldier experiences orthostatic intolerance while standing at attention for an extended period with their legs locked. The fainting response in normal circumstances would correct this problem, as the body would become horizontal and allow blood to flow back to the brain easier. While suspended in a harness, this is not the case because the worker remains upright. The lack of proper oxygen levels in the blood will adversely affect vital organs such as the kidneys. This can result in kidney failure and even death within thirty minutes. Some symptoms a worker may experience due to suspension trauma may be paleness of skin, faintness, breathlessness, sweating, hot flashes, nausea, and dizziness.

FIGURE 52
Using a bowline knot

Trauma Straps

Since suspension trauma is dangerous, every effort must be made to rescue a fallen worker as quickly as possible. The longer the victim of a fall hangs in a suspension harness, the more vulnerable they will be to trauma. In some instances, an immediate rescue cannot be safely executed. In the past, when workers had to be left hanging before being rescued, a rope with a bowline knot could be dropped down to them. The fallen worker's feet could be inserted into the rope to relieve the pressure, as shown in Figure 52.

FIGURE 53
Types of trauma straps



Today, special protective gear known as trauma straps are used to help prevent or forestall the onset of suspension trauma. These consist of a pair of straps, which may be hooks or loops, as shown in Figure 53. The hook-type trauma straps are released from the pouches located at each side of the waist. Once the straps are released, the left strap, which is equipped with a hook, is attached to the right strap, which is equipped with a ring. These straps are adjustable for proper fit. The straps then become a brace that will allow the worker to stand in the harness. The loop-type trauma straps are coiled in pouches located at the hips. As these straps are released, there is no need for adjustment. The worker will place each foot in the appropriate loop, depending on their height, and proceed to stand in the straps. Both of these types of straps enable the hanging worker to use leg muscles to take the weight off of the arteries in the groin area to restore normal blood circulation in the legs until help arrives. Figure 54 shows a worker standing in trauma straps.

SAFETY TIP

A fallen worker can deploy trauma straps to create a place that the worker can step into and press against to stand up. Trauma straps are typically packaged in two pouches that attach to each side of a harness.

Trauma straps are typically coiled in a pouch and attached to a fall harness at the hips, as shown in Figure 55. However, not all full-body harnesses are equipped with trauma straps, even when they have been provided by the manufacturer. This is because workers may remove them to make room for tool bags or other equipment.

Preventing Suspension Trauma

There are simple steps that can be taken to reduce the threat of suspension trauma during a fall incident. These include a well-organized fall protection and rescue plan for all work that will be done at heights, thorough training in the use of fall protection equipment and rescue techniques, and the use of trauma straps on all fall gear. Observing the following recommendations may further reduce the risk of suspension trauma:

- Construction personnel should never perform work that requires the use of the harness if they are alone.

FIGURE 54
Standing in trauma straps

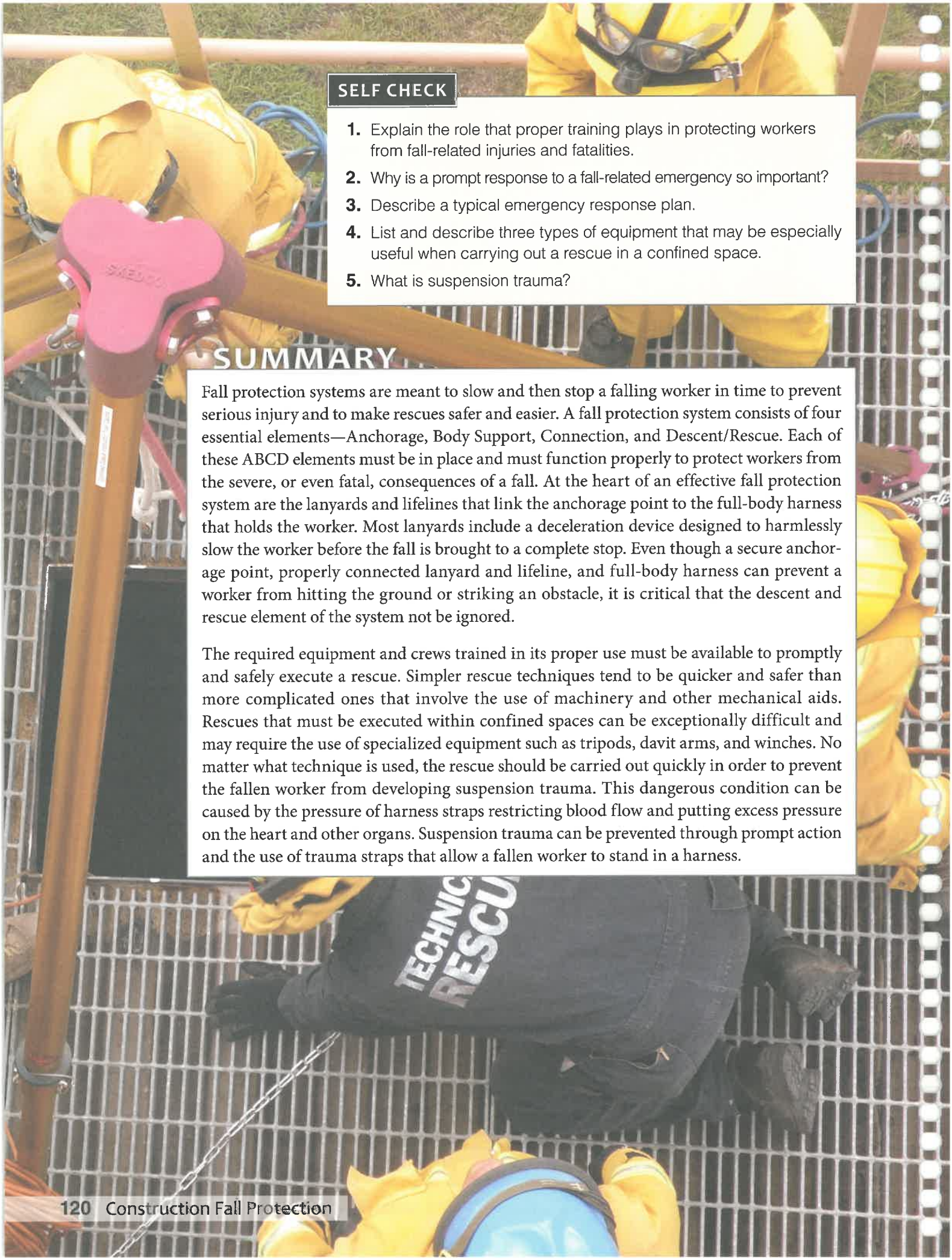
FIGURE 55
Trauma strap pouch

- Fallen workers must be kept conscious, if possible, by talking to them or applying cold compresses to the back of the neck.
- Workers should be trained to pull their knees up or push against any available footholds.
- If trauma straps are not available, a rope with a bowline can be lowered to the worker to serve the same purpose.
- Trauma straps should be made a part of all PFAS.
- For at least 30 minutes following rescue, a fall victim must be in a seated position with legs bent rather than in a lying position.

Once the worker has been rescued, it is important that they be treated as if they have experienced suspension trauma—especially if the worker was suspended longer than five minutes. When a worker is recovering from being suspended and experiencing suspension trauma, they should not be allowed to stand or lay flat on the ground. The leg straps should be slightly loosened and the worker should be left in the sitting position with their knees near their chest for at least 30 minutes. This will allow the blood that has pooled in the legs to be slowly released back into the rest of the body. The blood that has pooled in the legs may have reduced oxygen levels and could increase the presence of waste materials. This blood may shock the body and organs if released too quickly, which could cause organ failure, brain damage, and even death. It is important for the most recent clinical treatment for suspension trauma be referenced, as the suggested treatment may change over time due to further studies and understanding of orthostatic intolerance.

SAFETY TIP

If the worker shows any symptoms of orthostatic intolerance, treatment should be conducted as if they are suffering from such trauma, regardless of the length of time the worker was suspended.



SELF CHECK

1. Explain the role that proper training plays in protecting workers from fall-related injuries and fatalities.
2. Why is a prompt response to a fall-related emergency so important?
3. Describe a typical emergency response plan.
4. List and describe three types of equipment that may be especially useful when carrying out a rescue in a confined space.
5. What is suspension trauma?

SUMMARY

Fall protection systems are meant to slow and then stop a falling worker in time to prevent serious injury and to make rescues safer and easier. A fall protection system consists of four essential elements—Anchorage, Body Support, Connection, and Descent/Rescue. Each of these ABCD elements must be in place and must function properly to protect workers from the severe, or even fatal, consequences of a fall. At the heart of an effective fall protection system are the lanyards and lifelines that link the anchorage point to the full-body harness that holds the worker. Most lanyards include a deceleration device designed to harmlessly slow the worker before the fall is brought to a complete stop. Even though a secure anchorage point, properly connected lanyard and lifeline, and full-body harness can prevent a worker from hitting the ground or striking an obstacle, it is critical that the descent and rescue element of the system not be ignored.

The required equipment and crews trained in its proper use must be available to promptly and safely execute a rescue. Simpler rescue techniques tend to be quicker and safer than more complicated ones that involve the use of machinery and other mechanical aids. Rescues that must be executed within confined spaces can be exceptionally difficult and may require the use of specialized equipment such as tripods, davit arms, and winches. No matter what technique is used, the rescue should be carried out quickly in order to prevent the fallen worker from developing suspension trauma. This dangerous condition can be caused by the pressure of harness straps restricting blood flow and putting excess pressure on the heart and other organs. Suspension trauma can be prevented through prompt action and the use of trauma straps that allow a fallen worker to stand in a harness.

Personal Fall Restraint and Arrest Systems

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. Which of the following is a secure connecting point capable of safely withstanding the forces exerted on a fall protection system during a fall?
   a. anchorage
   b. support
   c. connector
   d. descent/rescue

2. Which of the following elements of a fall protection system is provided by a full-body harness?
   a. anchorage
   b. support
   c. connector
   d. descent/rescue

3. Which of the following elements of a fall safety system often includes a braking mechanism or energy-absorbing device designed to reduce the energy transferred to a falling worker's body and help prevent injury?
   a. anchorage
   b. support
   c. connector
   d. descent/rescue

4. A(n) _____ is a connector component usually made of steel or aluminum with a double-action, self-locking gate sometimes referred to as a keeper.

5. Which of the following rescue techniques is usually the quickest and safest option and is preferred when practical?
   a. self-rescue
   b. assisted self-rescue
   c. mechanically aided rescue
   d. rescue pickoff

6. A secure anchorage, body harness, and connector will provide adequate protection from falls and fall-related injuries. (True; False)

7. Which of the following rescue techniques is difficult to execute safely and generally should be attempted only as a last resort?
   a. self-rescue
   b. assisted self-rescue
   c. mechanically aided rescue
   d. rescue pickoff

8. While all parts of the fall arrest system are necessary and none are dispensable, the key element is the personal all arrest system, consisting of a lanyard, lifeline, or other connecting device that links the anchorage to the _____ _____ and supports the fallen worker until rescue is possible.

9. The most common lanyard lengths are ____.
   a. 3′-0″ and 5′-0″
   b. 4′-0″ and 6′-0″
   c. 5′-0″ and 7′-0″
   d. 6′-0″ and 9′-0″

10. Once a lanyard has been used to arrest a fall or the shock absorber has been deployed, it should be removed from service. (True; False)

11. Because of its versatility, the _____-_____ _____, also known as the 100 percent tie-off lanyard, is becoming increasingly popular among safety experts and construction professionals.

12. A(n) ____ is a type of lanyard that is sometimes used when an anchorage connector is not available and that can serve as both a means of connection and an anchorage connector.
   a. adjustable lanyard
   b. positioning lanyard
   c. tie-back lanyard
   d. shock-absorbing stretch lanyard

13. A ____ SRD has a maximum arresting force of 1,350 pounds and limits free-fall distance to 24″ or less.
   a. Class A
   b. Class B
   c. Class C
   d. Class D

14. Intended for use with vertical lifelines, _____ _____ are designed to slide easily during a climb and then lock tightly during a fall.

15. Once properly connected, workers should not walk too far away from an overhead anchorage as this increases the risk of a dangerous _____ _____.

16. All personal fall restraint system snap hooks and D-rings must be proof-tested to a minimum load of ____ without deforming or breaking.
   a. 1,800 pounds
   b. 2,400 pounds
   c. 3,000 pounds
   d. 3,600 pounds

17. A(n) _____ _____ system is a personal fall protection system that allows workers to use both hands to complete tasks.

18. Preparing for a fall or other construction site emergency requires thorough training and a well-organized _____ _____ _____.

19. A ____ offers versatility and a variety of base configurations and can be used to hoist fallen workers over large openings.
    a. tripod
    b. specialized harness
    c. davit arm
    d. winch

20. One limitation of the tripod is the size of the confined space opening. (True; False)

21. When using a winch to rescue a fallen worker from a confined space, a specialized harness with _____ on the top of both shoulder straps may be required.

22. Suspension trauma is also known as ____.
    a. harness hang syndrome
    b. orthostatic intolerance
    c. fall-induced pneumonia
    d. fall panic

23. Which of the following is a safety device consisting of hooks and loops and allows a fallen worker to stand in a harness?
    a. trauma straps
    b. knot loop
    c. knot tie
    d. harness hoops

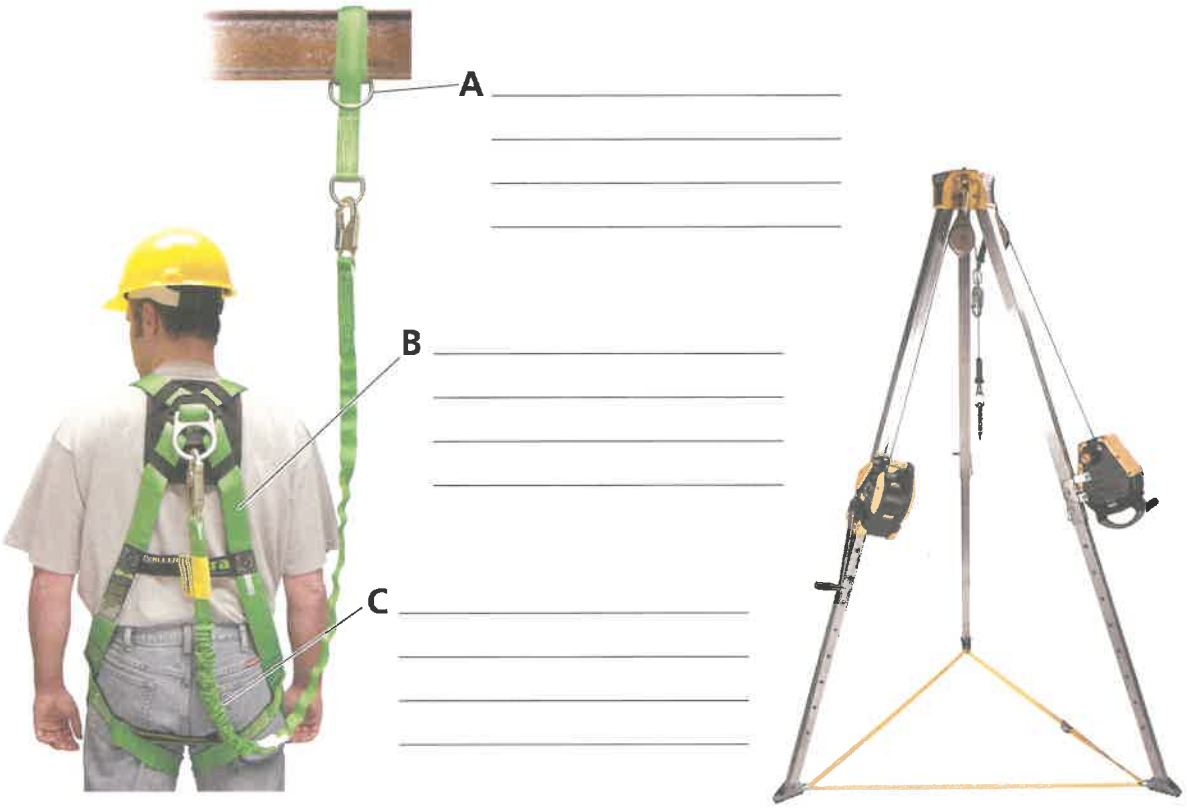
24. The pendulum motion of a fallen worker swinging beneath an anchor point is often referred to as _____ _____.

25. When working at height, construction personnel may be protected by a(n) _____ _____ _____ _____, a safety system consisting of an anchorage, connectors, and full-body harness working together to stop a fall and minimize the arresting forces imposed on a worker's body.

WORKSHEET 1

ABCDs of Fall Protection

Instructions In the spaces provided next to the figures below, tell what each of the four letters stands for and give a brief description of the purpose of each.



WORKSHEET 2

Matching Terms

Instructions Match the term with the correct definition.

_____ **1.** Swing fall

_____ **2.** Personal fall arrest system (PFAS)

_____ **3.** Self-retracting devices (SRDs)

_____ **4.** Lanyard

_____ **5.** Rope grab

_____ **6.** Suspension trauma

_____ **7.** Connector

_____ **8.** Anchorage point

_____ **9.** Horizontal lifeline

_____ **10.** Vertical lifeline

_____ **11.** Deceleration device

_____ **12.** Full-body harness

_____ **13.** Positioning device

_____ **14.** Anchorage

A. Body harness that allows a worker to work hands-free and to be supported on an elevated vertical surface

B. Flexible length of rope or wire rope that connects to an anchor point at one end and to be used with a rope grab along its length

C. Secure point of attachment for lifelines, self-retracting devices (SRDs), lanyards, and deceleration devices

D. Fall protection equipment made of strapping which secures the worker in a manner that will distribute the fall arrest forces over the thighs, pelvis, waist, chest, and shoulders

E. Mechanism designed to slow a falling worker and dissipate or limit the kinetic energy imposed on the worker during a fall arrest; also known as a shock-absorbing device

F. Retractable lanyard that relies on inertia to activate a braking mechanism housed in a specially designed block

G. Condition that exists when a worker's anchorage point is not directly above the worker, causing the body to act like a pendulum in the event of a fall

H. Secure connecting point capable of safely withstanding the forces exerted on a fall protection system during a fall

I. Friction-activated device that automatically engages a lifeline and locks to stop a falling worker

J. Devices that connect the full-body harness to the anchorage system

K. Flexible length of fiber rope, wire rope, or strap which can be securely attached to a body harness, deceleration device, lifeline, or anchorage

L. Synthetic fiber rope, wire rope, or rail system used as part of a complete personal fall arrest system that attaches between two anchor points

M. Safety system consisting of an anchorage, connectors, and a full-body harness working together to minimize the arresting forces imposed on a worker's body in the event of a fall

N. Effect which occurs when the human body is held upright without any movement for a period of time

WORKSHEET 3

Fall Protection Components Identification

Instructions Match the figure with the correct component.

_____ **1.** Descent control harness

_____ **2.** Ladder climbing harness

_____ **3.** Work positioning harness

_____ **4.** Carabiners

_____ **5.** Snap hook

_____ **6.** Rope grab

_____ **7.** Cable lanyard

_____ **8.** Adjustable lanyard

_____ **9.** SRL-R

_____ **10.** Davit arm

A. 

B. 

C. 

D. 

E. 

F. 

G. 

H. 

I. 

J. 

WORKSHEET 4

Questions and Answers

Instructions Read each question and write your answers in the blanks provided.

1. An anchorage is a secure connecting point capable of safely withstanding the forces exerted on a worker and the worker's fall protection system during a fall. List two types of anchorage and their required strengths.

2. In order to serve as part of a PFAS, an anchorage must have an anchorage point—a secure place of attachment for lifelines, self-retracting devices (SRDs), and lanyards. List three secured places for anchorage points.

3. Connectors are devices used to attach parts of the personal fall arrest system to an anchorage point. Connectors are found on either end of a lanyard, SRL, or connecting device. List three types of connectors.

4. Describe a personal fall restraint system.

5. Describe a positioning device and explain its use.

6. A lanyard is a flexible length of fiber rope, wire rope, or strap that can be securely attached to a body harness, lifeline, or anchorage. Describe a lanyard with a deceleration device.

7. Self-retracting devices are retractable lanyards that rely on inertia to activate a braking mechanism housed in a specially designed block. List three types of self-retracting lanyards and describe how and where they would be used.

Questions and Answers (continued)

8. Explain the difference between vertical and horizontal lifelines.

9. Why is prompt rescue response so important?

10. List the two types of trauma straps and describe how they are used.


GUARDIAN
GUARDIAN

CHAPTER 5

Selecting, Inspecting, and Wearing Fall Protection Equipment

INTRODUCTION

Safety equipment can prevent injuries and save lives, but to serve its purpose, this equipment must be properly selected, inspected, and worn. In order to select and make proper use of the required fall protection equipment, workers must have a basic understanding of the physics of falling objects and persons and how speed and distance relate to the forces exerted at impact.

Workers must also understand how to properly inspect their fall protection equipment to ensure it is in good working order and free of any damage. If safety equipment is not in good working condition or worn improperly, it may fail to function and, in some cases, may do more harm than good. For this reason, workers must be completely familiar with their safety equipment.

This chapter lists the equipment recommended for various safety systems and explains how it is properly used and maintained. The requirements cited in this chapter are from OSHA and OH&S and are comparable in their requirements.

CONTENTS

OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. Explain how fall clearance is evaluated.
2. Explain the process of selecting the proper fall protection equipment.
3. Demonstrate the ability to properly inspect a full-body harness.
4. Demonstrate how to properly inspect a lanyard.
5. Demonstrate the ability to properly inspect a self-retracting device (SRD).
6. Demonstrate the ability to properly don a full-body harness.
7. Explain how to properly doff and store a full-body harness.

KEY TERMS

Key Terms are in order of appearance.

fall clearance height at which a worker must attach a lifeline or lanyard to an anchorage to avoid contact with a lower level or obstacle in the event of a fall

free-fall distance distance a falling worker travels from the moment the fall occurs to the moment the fall arrest system is activated

webbing woven fabric used on fall protection equipment components such as full-body harnesses and lanyards

impact indicator visual device that shows a fall arrest system has been subject to a fall

self-locking snap hooks self-closing device with a keeper or latch that will remain closed until manually opened with two consecutive actions taken by the user

donning act of putting on protective gear such as fall protection equipment

doffing act of taking off protective gear such as fall protection equipment

1 Understanding Fall Clearance

Construction professionals working at heights must know how to protect themselves and others from falls. This requires a basic understanding of the physics related to falls and how distance and speed determine the force with which a falling person or object strikes a surface. Workers also must understand the importance of **fall clearance**, the height at which a worker must attach a lifeline or lanyard to an anchorage in order to avoid contact with a lower level or obstacle in the event of a fall.

Physics of Falls

The two most important factors influencing a free fall and the force with which an object strikes a surface are speed and weight. For example, a worker weighing 180 pounds and carrying 20 pounds of tools would accelerate quickly and strike a surface below with extraordinary force after less than one second of free fall. In just .61 seconds, the worker would travel 6′-0″, reach a speed of 13.4 mph, and strike the ground or other solid surface with a force equal to 1,200 pounds, or the weight of about six workers and their tools. To put this into perspective, .61 seconds is roughly the same time it takes to blink twice.

Evaluating Fall Clearances

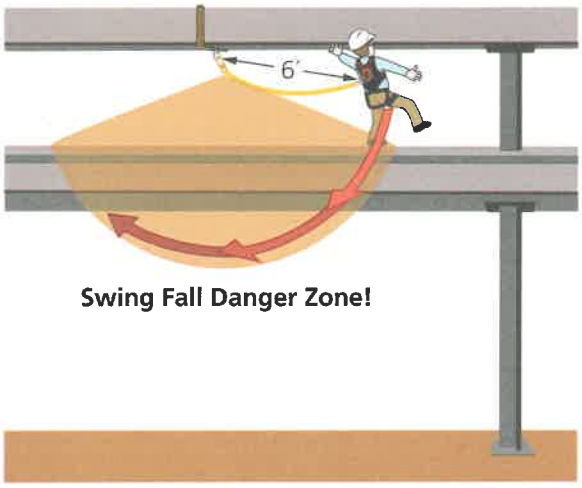
Fall clearances must be properly evaluated by a competent person to determine the fall protection system required to ensure worker safety. The competent person will take into consideration free-fall distances and all obstructions such as I-beams, jobsite equipment, and impalement hazards. **Free-fall distance** is the distance the worker travels from the moment the fall begins to the moment the fall arrest system is activated. The PFAS will be selected based on this evaluation.

SAFETY TIP

Tie off in a manner that limits free fall to the shortest possible distance to reduce impact on the body.

OSHA and OH&S state that the PFAS equipment must be installed so that a falling worker's free-fall distance is no more than 6′-0″, and the worker is unable to contact a lower level. Because personal fall arrest systems do not prevent falls, the anchorage must be high enough to ensure that the personal fall arrest system, and not the next lower level, stops the falling worker. Free-fall distance, lanyard length, shock absorber elongation, and body harness stretch are all taken into consideration when determining the proper height of an anchorage.

FIGURE 1
Swing fall



Swing fall can be a dangerous situation regardless of the type of personal fall arrest system being used. If the anchorage point is not directly overhead, the pendulum effect known as swing fall will always be present if a fall occurs. Swing fall is shown in Figure 1. The possibility of striking an object or lower level is another concern that the competent person and the workers must evaluate before choosing the proper personal fall arrest system. If a worker is 6′-0″

away from the anchorage point and a fall occurs, the worker will swing about 6′-0″ to the other side of the anchorage point.

Calculating Fall Clearance

Calculating fall clearance is a step that must not be overlooked. Depending on the location of the anchorage point, the type of lanyard being used, the free-fall distance, the stretch in the harness, and the deceleration distance, the length of the fall may vary dramatically. The diagram in Figure 2 shows a fall clearance calculation based on a worker falling directly in line with the anchor point. Potential swing fall and other hazards should always be considered when calculating fall clearance.

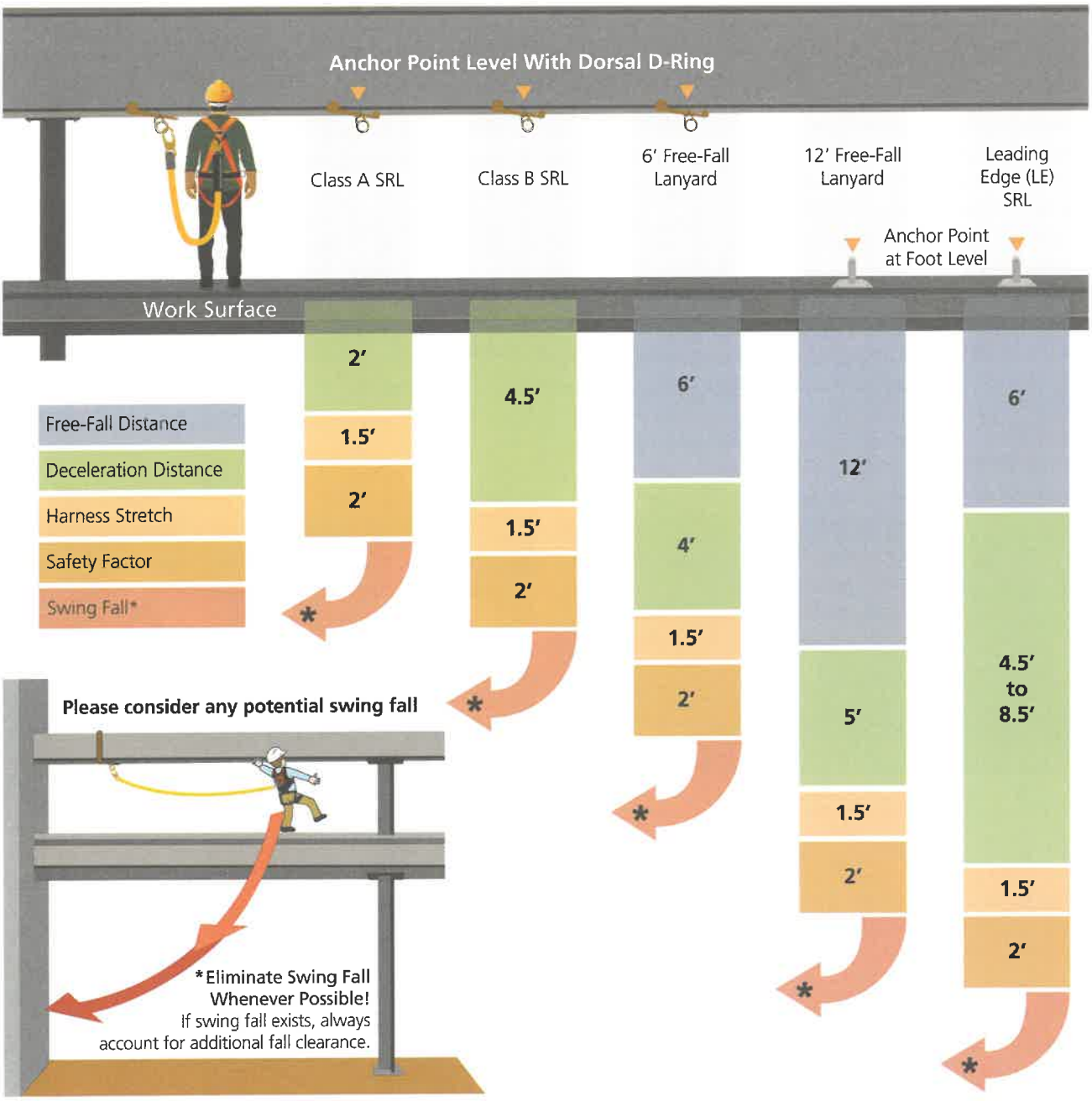
SAFETY TIP

Work directly under the anchorage, whenever possible, to avoid injury resulting from swinging and striking another object during a fall.

FIGURE 2

Fall clearance diagram

Fall clearance calculation shown based on standing worker falling directly in line with anchor point. Always consider potential swing fall and other hazards when calculating fall clearance.



SAFETY TIP

Never attach multiple 6′-0″ lanyards to each other; doing so increases the free-fall distance and impact forces on the equipment and body.

SAFETY TIP

The anchorage must be at a height that will not allow a worker to strike a lower level in the event of a fall.

SAFETY TIP

Always be aware of surrounding objects. If a fall occurs, the worker is likely to swing into an object and be seriously injured.

The following example calculates the distance using a Class A SRL with an anchorage point directly above the head.

- 2′-0″ = distance the worker would fall before the lanyard would begin to arrest the fall
- 1′-6″ = harness stretch
- 3′-0″ = safety factor
- 6′-6″ = total fall distance

The following example calculates the distance using a 6′-0″ shock-absorbing lanyard anchored at floor level.

- 5′-6″ = the average height of the dorsal D-ring
- 6′-0″ = distance the worker would fall before the lanyard would begin to arrest the fall
- 4′-0″ = deceleration distance
- 1′-6″ = harness stretch
- 3′-0″ = safety factor
- 20′-0″ = total fall distance

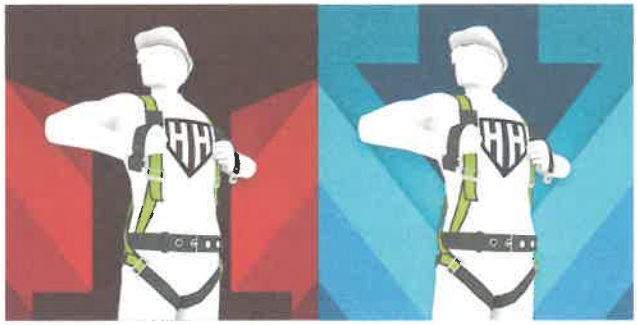
Some manufacturers have an application (app) that can be accessed from a smartphone or tablet that makes it possible to calculate fall clearance. In addition to calculating fall clearances, some of these apps can perform lanyard and SRL calculations, including swing fall, and may have the ability to e-mail the results to coworkers. There are also game-style apps available in which making key decisions relating to the use of a fall arrest system can be simulated, such as the app Harness Hero. Figure 3 shows several icons of apps used for calculating fall clearances.

FIGURE 3

Fall clearance application icons

Fall clearance calculation applications for the jobsite

Harness Hero application for selection and inspection



2 Selecting the Proper Fall Protection Equipment

Recommended fall protection equipment varies according to the purpose of the safety system, jobsite circumstances, and the type of tasks a worker will be performing. For instance, the safety systems used for personal fall arrest are not the same as those used for work positioning or descent and rescue.

The selection process begins with the site evaluation. This evaluation will identify the fall hazards the workers will be exposed to. The fall protection equipment selected for a job will be determined by a variety of factors. Before selecting the equipment, certain questions must be answered. Examples include the following:

- How high is the work?
- Will the work be done on a roof, leading edge, or scaffold?
- What safety equipment is already present at the work site?
- How adequate are the passive fall protection systems at the site?
- If an active fall protection system will be required, is the worker thoroughly trained in its use?

Once the evaluation process is complete, the appropriate fall protection system must be determined. For instance, if leading edge work must be done over the edge, a personal fall arrest system would be the best choice. If the work will be close to a leading edge but it will not be necessary to get over the edge, a fall restraint system will keep the worker out of the fall hazard area. If a worker will be working on a concrete form and will need to work in a fixed position, then a positioning device system in conjunction with a personal fall arrest system would be best suited for that type of work. A worker who has to climb a fixed ladder would use a personal fall arrest system with a vertical lifeline and a rope grab.

Regardless of the type or purpose of the equipment, it is imperative that it be properly used and maintained. The following scenario provides an account of a fall accident, and questions how it could have been prevented.

TRADE TIP

Fall protection begins with identification of all fall hazards on the jobsite. When a fall hazard is identified, there are two acceptable options: eliminate the hazard or provide protection against it.

TRADE TIP

A fall protection system consists of multiple compatible components. This is necessary for the whole system to function safely and properly to maximize protection for the worker.

SAFETY TIP

All workers can be exposed to a fall hazard, regardless of their trade. Everyone should be aware of openings in floors or walls to prevent accidents.

FALL AWARENESS SCENARIO

A 45-year-old floor coverer was fatally injured when he fell 32′-0″ from a window, striking his head on the concrete sidewalk below. The victim and a coworker were installing carpet in a commercial building that was under construction. The workers were attempting to unload rolls of carpet from a three-sided box, also referred to as a skip box, through a window after removing the guardrail. The victim was working from inside the skip box, which was elevated to an unfinished fourth-story window by a variable rough terrain forklift. According to his coworker, the victim had one foot on the window sill and one foot on the end of a carpet roll that was protruding from the skip box. When the victim lifted his foot off the window sill, all his weight shifted onto the roll of carpet. The carpet roll and victim fell 32′-0″ to the concrete sidewalk. His head struck the concrete sidewalk, and a second roll of carpet fell out of the box and landed on him. EMS was called immediately and arrived on the scene quickly. The victim was transported to the hospital where he later died from injuries sustained from the fall. Figure 4 shows images from the actual incident.

- How could this accident have been prevented?
- Have you ever known anyone who fell after removing a guardrail?

FIGURE 4

Incident images

Three-sided skip box used to elevate carpet rolls to window

Incident site showing opening from which victim fell

View of window opening from inside building with arrows pointing to brackets that held up guardrail

Personal Fall Arrest System

The use of a personal fall arrest system (PFAS) is recommended for anyone working at elevation or exposed to fall hazards. According to OSHA and OH&S, anchorage points should be capable of supporting 5,000 pounds and can be an anchor strap, beam slide, or a bolt-hole anchor.

The type of body harness suitable for a personal fall arrest system depends on the type of work being performed. Harnesses may be equipped with hardware for climbing, positioning, retrieval, suspension, or other types of work and must meet all of the same basic requirements in terms of function.

According to ANSI standards, a body harness must be capable of supporting a person with a combined tool and body weight of 130–310 pounds, although there are systems available for heavier weights. These harnesses must be used with an anchorage device and a deceleration device that limits the impact forces of a fall to 1,800 pounds or less, as specified by OSHA and OH&S.

Types of Body Harnesses

When selecting the proper body harness, a harness designed for a specific application must be chosen. The correct harness for the job must be chosen from a variety of available harnesses, including positioning harnesses, descent/rescue harnesses, ladder climbing harnesses, and fall restraint systems. Wearing the wrong type of harness may put a worker at risk of serious injury or even death in the event of an accident. Figure 5 shows a variety of body harnesses.

FIGURE 5
Variety of harnesses

(A) Positioning harness

(B) Ladder climbing harness

(C) Descent/rescue harness

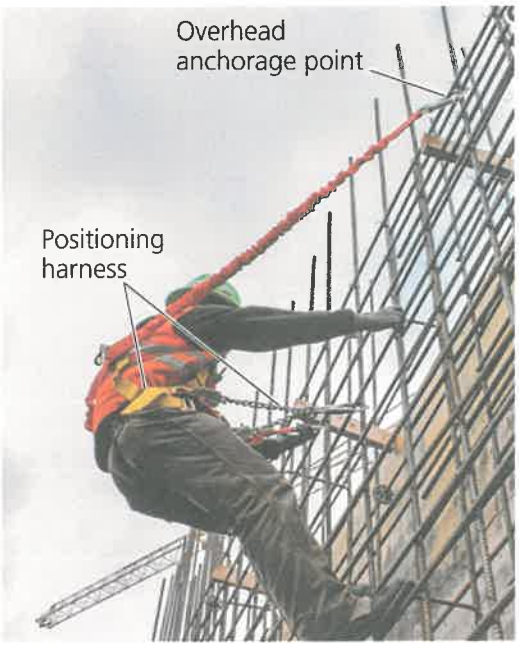


FIGURE 6
Positioning device system

Harnesses are equipped with different components to address specific needs. The types of webbing, D-rings, and lanyard connections will provide the proper solution for the situation. It is important to ensure that the harness fits well, and that the shoulder, waist, and leg straps are adjusted properly. Some of the more common harness types are described here.

Positioning Harness A positioning harness is used to hold a worker in place while allowing the worker to work hands-free to perform tasks. This harness will include integral waist belts with D-rings located on the hips. When using this positioning harness the worker must understand that the waist belt D-rings are not meant for fall arrest applications, nor should they be confused with fall restraint systems. When using the positioning harness, the worker must limit the fall to 2′-0″ or less, as required by OSHA and OH&S. This harness must have a dorsal D-ring to attach to an overhead anchorage point. Positioning harnesses must also use a fall arrest system because workers should not solely rely on positioning devices. A positioning device system is shown in Figure 6.

SAFETY TIP

Never use positioning D-rings to arrest a fall. A fall that occurs while only using positioning D-rings could severely injure a worker's lower back since the impact of the fall is not evenly distributed over the worker's entire body.

Descent/Rescue Harness Descent and rescue harnesses are primarily used in confined space applications where workers must enter tanks, manholes, or similarly restricted environments where assistance must reach them from above in the event of an emergency. These harnesses will have a D-ring located on the chest for ladder descent or a set of D-rings located on the shoulders for retrieval. D-rings for retrieval are attached to a retrieval device such as a davit arm. The retrieval hardware makes rescue of an immobile worker more efficient, and distributes lifting forces more evenly. Figure 7 shows a descent/rescue harness.

FIGURE 7
Descent/rescue harness

FIGURE 8
Ladder climbing harness

Ladder Climbing Harness Climbing ladders that extend 24′-0″ or more require the use of a ladder climbing harness. These harnesses have a front D-ring attachment for connection to a vertical lifeline. This harness allows the worker to ascend and descend the ladder in the safest manner possible using three points of contact at all times. Figure 8 shows a ladder climbing harness.

Fall Restraint System Fall restraint systems are designed to prevent a worker from entering an area where a potential fall hazard exists. This system eliminates the possibility of a fall and incorporates a full-body harness and fixed-length or adjustable lanyards or SRLs that limit movement. Lanyards must be attached to anchor points that are positioned to prevent workers

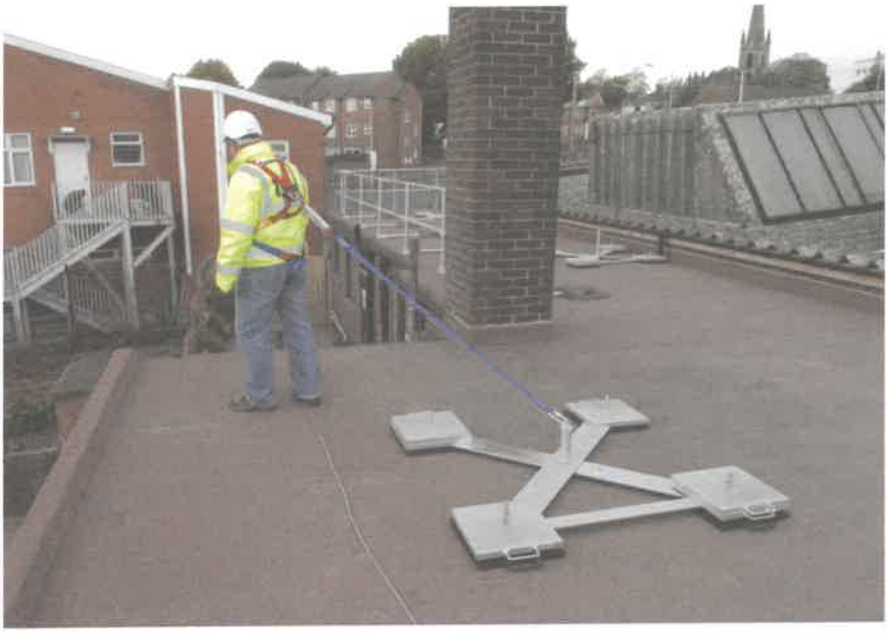


FIGURE 9
Fall restraint system

SAFETY TIP

Always have a rescue plan when working at heights or in confined spaces. Having a rescue plan will limit the time you are exposed to suspension trauma or hazardous environments.

SAFETY TIP

When ascending or descending a ladder, best practice is to raise and lower your tools using a rope and bucket or similar device instead of carrying them. Carrying this additional weight will increase the impact of a fall.

TRADE TIP

Fall arrest systems should only be used if fall restraint is not feasible. Fall restraint will not allow the worker to be exposed to a fall.

from going beyond the edge where a fall may occur. If the worker will not need to reach a leading edge, this would be the appropriate fall protection system. A fall restraint system is shown in Figure 9.

The equipment recommended in this section can be used for most of the purposes and situations listed. However, the required components may vary, depending on the circumstances. When using personal fall arrest systems, a full understanding of the components involved is needed in order to work safely.

Complete fall protection systems are designed to protect workers from fall injuries, and it is important to make sure that workers have everything needed to use it effectively. By selecting equipment that meets OSHA, OH&S, and ANSI standards, employers help make their fall protection systems as effective as possible. Protecting and maintaining equipment, proper training, and providing sufficient access to certified anchorage points will help to create the most effective system possible.

Fall Protection Choices

It is important to understand the proper selection of fall protection for the work being performed. Certain work tasks will have different requirements. Choosing the best possible fall protection for the task at hand could be a life-saving decision. The following selection exercises are provided as practice for making those decisions.

SELECTION EXERCISE

Scenario

Some lead paint abatement needs to be done in a water tank that is 25′-0″ tall. The only access point is at the top of the tank. The location of the abatement is 20′-0″ down into the tank at the water inlet pipe.

Anchorage	Anchorage Connector	Harness Type	Lanyard Type
• Tripod • Davit arm • Ladder	• Carabiner • Snap hook • Rope grab	• Full-body harness • Body belt • Full-body harness with front or shoulder D-rings	• 12′-0″ shock-absorbing lanyard • 30′-0″ SRD • Vertical lifeline

- What system would be the best choice for this scenario?
- Why is this the best system to use for this scenario?

Possible Answer

The worker should use a descent/rescue full-body harness. The system will include a full-body harness with front and/or shoulder D-rings, and an SRL-R connected to the D-rings with snap hooks. The SRL-R will be securely attached to a leg of the tripod with the cable running through a pulley.

SELECTION EXERCISE

Scenario

Before the exterior framing can be started, metal stud clips must be welded to the steel frame of the building. Due to the tight space in between the buildings, a MEWP cannot reach the work. The work will be done from the deck and the worker will be required to lean over the edge to properly complete the task.

Anchorage	Anchorage Connector	Harness Type	Lanyard Type
• Support beam • Concrete form • Steel deck	• Anchor strap • Beam slide • Stationary beam clamp • Form hooks	• Full-body harness	• Shock-absorbing lanyard • Self-retracting device • Lifeline • Rope grab

- What system would be the best choice for this scenario?
- Why is this the best system to use for this scenario?

Possible Answer

The worker should use a personal fall arrest system. The system will include a full-body harness and SRL-LE connected to a beam slide that is attached to a support beam.

SELECTION EXERCISE

Scenario

The contractor needs a carpenter to tie a vertical mat of #9 Steel Rebar for a foundation wall. The wall is 10′-0″ tall with 2 mats 6″ on-center. Time is an important factor in completing this task, as the form needs to be ready to pour the morning of the next day. The most effective way is for the rebar to attach to the vertical mat in a fixed position while tying the rebar mat.

Anchorage	Anchorage Connector	Harness Type	Lanyard Type
• Support structure • Concrete form • Rebar mat	• Snap hooks • Carabiners • Anchor strap	• Full-body harness with body belt • Body belt with D-rings	• Positioning hooks • SRD • 6′-0″ lanyard

- What system would be the best choice for this scenario?
- Why is this the best system to use for this scenario?

Possible Answer

The worker should use a positioning device system with a full-body harness. The system will include a full-body harness with a body belt and positioning hooks connected to a rebar mat. Also, the worker should have an SRD for fall arrest.

SELECTION EXERCISE

Scenario

The exterior of a building has a receiving area on the second floor for material. The material must be boomed up with a forklift. The doors must be opened and the guardrails removed so as not to impede the delivery. The employer requires a certain system that keeps the worker from entering the fall hazard area.

Anchorage	Anchorage Connector	Harness Type	Lanyard Type
• Structural beam • Guardrail • Steel column	• Beam slide • Anchor strap • Stationary beam clamp	• Full-body harness • Body belt	• SRD • Positioning hooks • 6′-0″ twin-legged lanyard • Adjustable lanyard

- What system would be the best choice for this scenario?
- Why is this the best system to use for this scenario?

Possible Answer

The employee is required by the employer to use a fall restraint system. The system will include a full-body harness and an SRL attached to a stationary beam clamp. The stationary beam clamp will be attached to a steel column.

SELECTION EXERCISE

Scenario

A 30′-0″ fixed ladder is the only access to the roof of a building. The roof membrane is leaking and in need of repair. A carpenter will need to climb the ladder to access, inspect, and repair the roof membrane.

Anchorage	Anchorage Connector	Harness Type	Lanyard Type
• Tripod • Davit arm • Ladder • Support structure	• Snap hooks • Carabiner • Anchor strap • Vertical lifeline	• Full-body harness • Body belt • Full-body harness with frontal D-ring	• Positioning hooks • SRD • 6′-0″ lanyard • 3′-0″ lanyard with rope grab

- What system would be the best choice for this scenario?
- Why is this the best system to use for this scenario?

Possible Answer

The worker should use a full-body harness with frontal D-ring. A 3′-0″ lanyard with rope grab connected to the front D-ring with snap hooks should be used. The 3′-0″ lanyard will be securely attached to the vertical lifeline, which is attached to a support structure above.

SELF CHECK

1. Explain the importance of fall clearance when determining the placement of PFAS anchorages.
2. What is the maximum free-fall distance that should be allowed by a properly functioning PFAS?
3. Describe the equipment recommended for a positioning device system.
4. List the types of equipment recommended for a descent/rescue safety system.
5. Describe the key components and equipment recommended for a rope grab fall safety system.

3 Inspecting a Personal Fall Arrest System (PFAS)

To ensure that a personal fall arrest system (PFAS) will function effectively and protect a worker from serious harm, it must be carefully inspected before each use. Although proper inspections play a critical role in the fall protection process, they are all too often overlooked or carried out in a hurried manner. Even though construction sites are frequently fast-paced, busy places where tasks must be completed by deadlines, workers must resist the temptation to take shortcuts when selecting and inspecting fall protection equipment. The Bureau of Labor Statistics (BLS) states that there were 4,674 worker fatalities in private industry in 2017. Excluding highway collisions, the leading cause of private sector worker deaths in the construction industry was falls. The total deaths in construction was 971, with 381 caused by falls; this equates to just over one death per day. The proper PFAS equipment must be selected and every component properly inspected before each use.

TRADE TIP

Safety is the most important objective for any jobsite no matter how strict the deadline is. Accidents are costly and create delays, making it increasingly difficult to meet deadlines.

Any component that fails to pass inspection, shows signs of wear, or is damaged in any way must be removed from service immediately, tagged, and turned over to a competent person for further evaluation. OSHA and OH&S require inspections prior to each use. It is important that the manufacturer's specifications regarding inspections be followed. Figure 10 shows pre-use inspection being performed.

FIGURE 10
Inspecting a PFAS

SAFETY TIP

Workers required to use fall protection should each be assigned their own harness. Workers sharing harnesses may increase the chances of damage to the harness, which could endanger themselves and others.

Full-Body Harness Inspection

Full-body harnesses include a considerable number of components, all of which are vulnerable to damage during use or storage. Figure 11 shows the components that should always be inspected before use to make sure they are sound and in good working condition. D-rings, buckles, keepers, and back pads must be inspected for various types of damage and distortion, as well as for sharp edges, burrs, cracks, and corrosion. Manufacturer identification labels should be inspected to make sure serial numbers and model numbers are legible; these numbers are important for keeping track of inspection records. The manufacturer identification labels inform the user of the proper use and weight restrictions, as does the inspection tag. Many manufacturers are now using an electronic radio frequency identification (RFID) chip to keep track of inspection records. See Figure 12. A scanner from the manufacturer is required to read the chip. The following harness elements and components must be examined closely during each inspection.

Webbing A woven fabric used on fall protection equipment and components, such as full-body harnesses and lanyards, **webbing** should be inspected before each use of a PFAS. To begin the inspection, the webbing should be gripped with hands held 6″–8″ apart. The webbing should then be bent into an inverted U to make damaged fibers or cuts easier to detect. This process is continued along the entire length of the webbing as both

How to Inspect Your Full-Body Harness

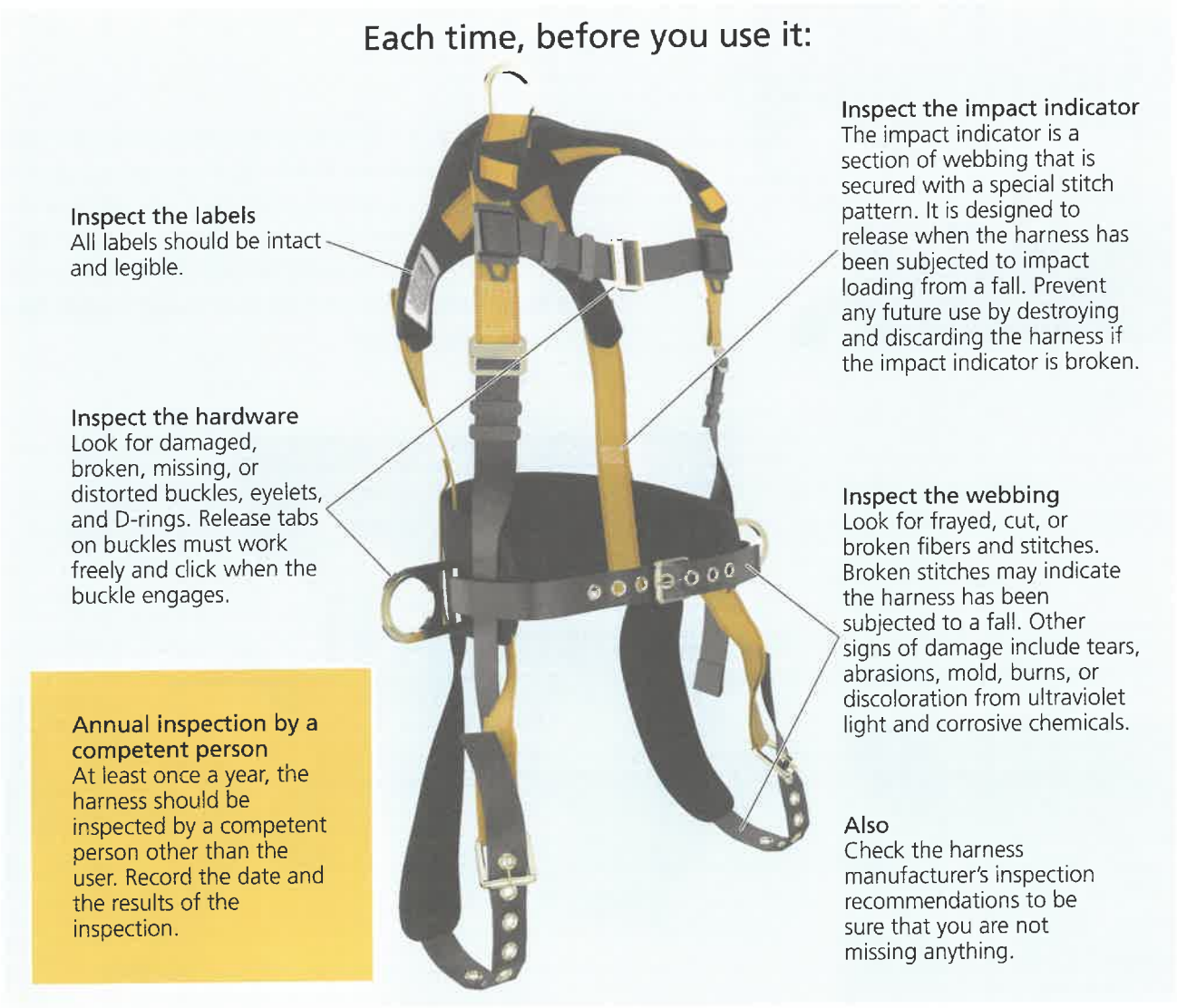


FIGURE 11
Chart of body harness components to inspect

FIGURE 12
RFID

FIGURE 13
Inspecting the webbing

sides of each strap are inspected, as shown in Figure 13. Frayed edges, broken fibers, pulled stitches, cuts, burns, and chemical damage should be looked for during the inspection.

D-Rings A D-ring is a D-shaped steel loop used on a personal fall arrest system for attaching a connecting device. D-rings can be bent, distorted, cracked, oxidized, or damaged in a number of ways. Figure 14 shows a D-ring being inspected for damage. It is essential that all D-rings be able to pivot freely. If a D-ring does not pivot freely, it could be a sign of non-visible damage.

FIGURE 14
Inspecting a D-ring

FIGURE 15
Inspecting the buckle attachment

Buckle and Quick Connector Attachments Buckles and quick connector attachments should be closely examined for unusual wear, cracks, deformities, and proper function; any of these may affect the strength of the component. Figure 15 shows the buckle attachment being inspected. The tongue of the buckle, which inserts into the grommet, can become worn from repeated buckling and unbuckling. The tongue should be inspected for bends, cracks, and excessive wear.

FIGURE 16
Inspecting the grommets

Grommets All grommets must be firmly seated in the webbing of the belt or leg strap. The grommet must be free of sharp edges, distortion, or cracks. Elongated grommets may be a sign that the equipment was used to arrest a previous fall and should be discarded. It is important to ensure all grommets are in place and that none are missing. Figure 16 shows grommets being inspected for damage.

Labels All labels should be in place, undamaged, and legible. A damaged label is shown in Figure 17.

PROCEDURE

How to Properly Inspect a Full-Body Harness

1. Hold the dorsal D-ring and shake the harness to get the shoulder and leg straps hanging freely.
2. Check to make sure labels are present and fully legible. See Figure 18.
3. Check the inspection tag to determine the date of the last inspection. See Figure 19.
4. Check the D-rings for distortion, cracks, or other damage. See Figure 20.
5. Slowly and thoroughly inspect all webbing throughout the entire harness for cuts, exposed warning threads, burns, or chemical damage. See Figure 21.

(continued)

FIGURE 17
Damaged label

FIGURE 18
Legible label

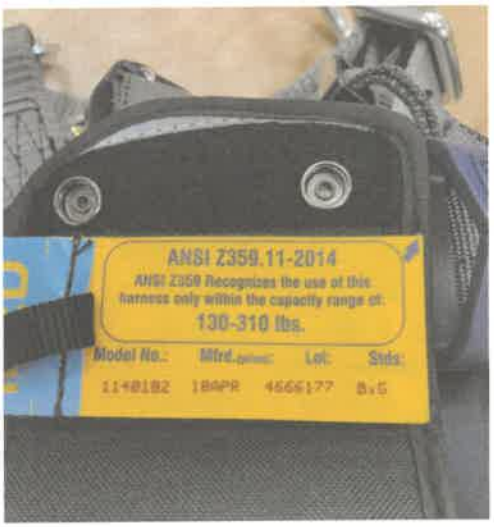


FIGURE 19
Inspection tag

FIGURE 20
Checking the D-rings

FIGURE 21
Inspecting the webbing

PROCEDURE *(continued)*

6. Check all buckles or quick connectors for proper functionality, distortion, nicks, or cracks. See Figure 22.
7. Check the leg straps and belt to ensure that no grommets are loose or missing. See Figure 23.
8. Check to make sure the harness adjustments are working properly.

FIGURE 22
Inspecting the buckles and quick connectors

FIGURE 23
Inspecting the leg straps for missing grommets

Lanyard Inspection

The inspection requirements are different for each type of lanyard. All lanyards are inspected by beginning at one end and working to the other end while slowly rotating the device so that its entire circumference is checked. In addition to inspecting the lanyards, all lanyard hardware should be checked, including self-locking snap hooks, carabiners, and D-rings. It is important for these components to be checked closely for damage, distortion, sharp edges, burrs, cracks, corrosion, weld marks, discoloration, oxidation, and improper operation. The lanyards themselves require different inspection procedures, depending on the type of lanyard being used. The following lanyards and their components should be inspected as per industry standards.

SAFETY TIP

Even though a worker may be certain the lanyard has not been used by other workers, inspecting the lanyard regularly will decrease the possibility of lanyard failure due to damage.

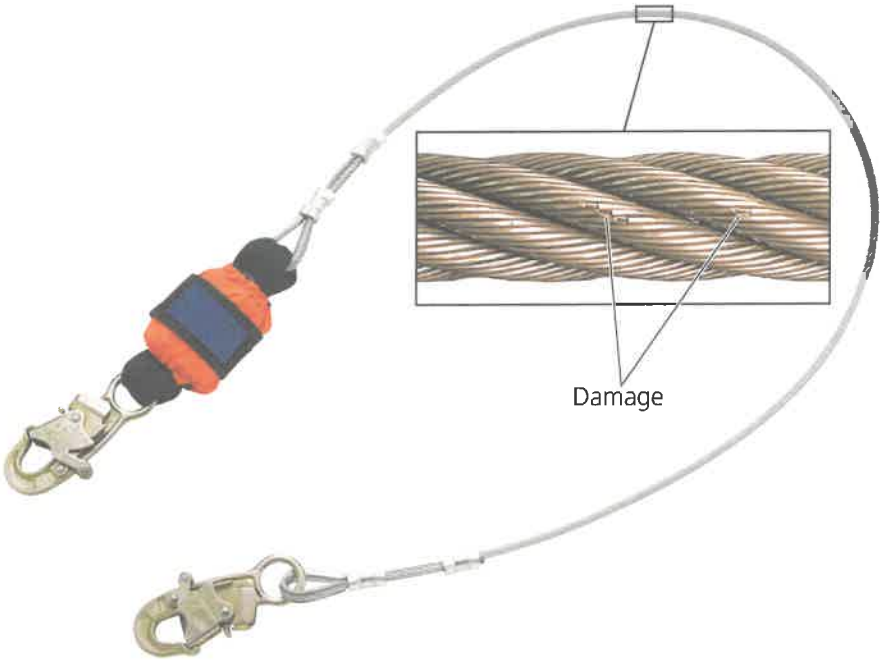


FIGURE 24
Wire rope lanyard with damage

Wire Rope Lanyard When inspecting wire rope lanyards, the device should be examined closely for cuts, frayed areas, or unusual wear patterns on the wire. The lanyard should be checked for broken strands that have separated from the wire rope. A wire rope lanyard with damage is shown in Figure 24.

SAFETY TIP

Always wear leather gloves when inspecting wire rope lanyards to prevent cuts and pokes from the sharp wires within the wire rope.

Web Lanyard When inspecting a web lanyard, the webbing should be bent, as shown in Figure 25, so that each side can be examined. The webbing is bent into an inverted "U" to make damaged fibers or cuts easier to detect. Swelling, discoloration, cracks, and charring are obvious signs of chemical, UV, or heat damage.

FIGURE 25
Inspecting a web lanyard

Rope Lanyard A rope lanyard should be rotated while checking from one end to the other. The rope should be checked for fuzzy, worn, broken, discolored, excessively stained, or cut fibers. The diameter of the rope should be uniform; areas weakened by extreme loads will appear thin. A rope lanyard with fray damage is shown in Figure 26.

FIGURE 26
Damage on a rope lanyard

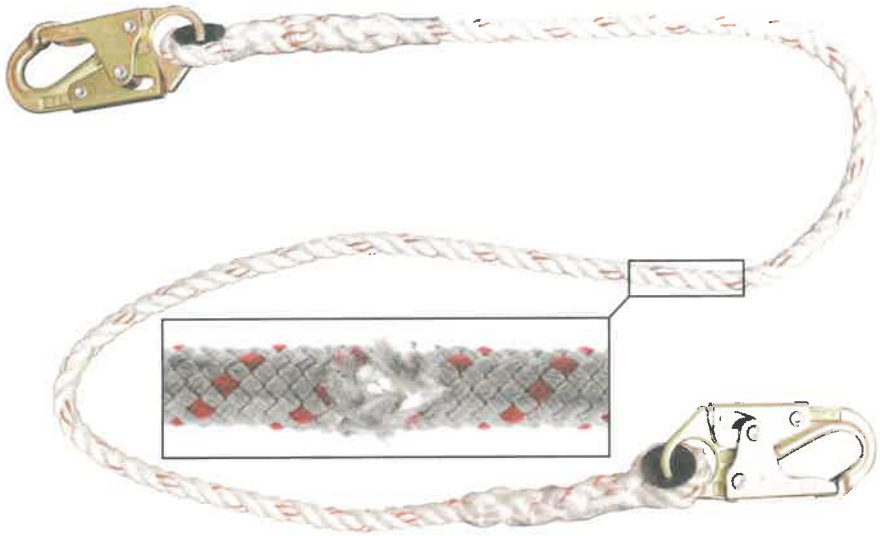


FIGURE 27
Inspecting a shock-absorbing stretch lanyard

Shock-Absorbing Stretch Lanyard A shock-absorbing stretch lanyard, also known as a deforming lanyard, should be inspected as if it were a web lanyard. See Figure 27. It is important that it be checked for signs of deployment, such as elongation. If there are any signs of deployment, the lanyard should be removed from service immediately.

Shock Absorber Pack Any of the previously mentioned lanyards may be equipped with a shock absorber pack. Vertical and horizontal lifelines may also use a shock absorber pack. The shock absorber pack must be examined for burn holes, tears, or any signs of deployment. See Figure 28. The stitching on areas where the pack is sewn to D-rings, belts, or lanyard should be examined and checked for loose strands, rips, and deterioration. The presence of any of these defects will render the pack and lanyard unsafe to use, and it must be removed from service.

Self-Locking Snap Hooks To ensure that self-locking snap hooks function properly, they should be examined closely for hook and eye distortions, cracks, corrosion, weld marks, or pitted surfaces. The gate should seat without binding and should be free of distortion or obstructions. The gate spring should exert enough force to firmly close the gate, and locks must prevent it from opening when closed. Figure 29 shows a damaged self-locking snap hook that is missing a gate spring.

Carabiners A carabiner is a high-tensile alloy steel connector that has a locking gate and is used primarily in specialized work such as scaffold

TRADE TIP

Shock-absorbing stretch lanyards are bulky and should be carefully inspected prior to each use.

FIGURE 28
Inspecting the shock absorber pack

FIGURE 29
Damaged self-locking snap hook

building and high-angle rescue. These devices should be inspected for sharp edges, burrs, cracks, weld marks, or corrosion, as well as for worn or damaged locking mechanisms. The gate must close and lock properly. A corroded carabiner is shown in Figure 30.

FIGURE 30
Corroded carabiner

PROCEDURE

How to Properly Inspect a Lanyard

1. Check to make sure all labels are present and legible. See Figure 31.
2. Inspect the length of the lanyard for damage to the webbing or wire rope, as shown in Figure 32.

(continued)

FIGURE 31
Legible labels

FIGURE 32
Inspecting the lanyard

SAFETY TIP

If a self-locking snap hook or carabiner does not close firmly enough, it may be forced open at the attachment point, which could cause an accident or even death.

TRADE TIP

Always inspect each component of the personal fall protection system according to the manufacturer's instructions.

PROCEDURE *(continued)*

3. Check to make sure the snap hooks and carabiners are free of damage, distortion, or corrosion and are in good working condition. Figure 33 shows inspecting a snap hook.
4. If equipped with a shock absorber pack, it should be inspected to ensure it is completely intact. See Figure 34.
5. If the lanyard is a shock-absorbing stretch lanyard, stretch the lanyard out and make sure it does not over-stretch, which would indicate it was subjected to a fall. See Figure 35.

FIGURE 33
Inspecting the snap hooks

FIGURE 34
Inspecting the shock absorber pack

FIGURE 35
Inspecting a shock-absorbing stretch lanyard

Self-Retracting Device Inspection

A self-retracting device (SRD) is a retractable lanyard that uses inertia to activate a braking mechanism, much like a vehicle's seat belt. As with other parts of a PFAS or similar safety system, SRDs must be carefully inspected before use. These types of lanyards may be made of steel cable or a web-type lanyard. The housing, lifeline, braking mechanism, spring, and self-locking snap hooks are critical areas that must be inspected. SRDs should be tagged and removed from service immediately if any part of the device is damaged. SRDs have a visual device known as an **impact indicator** that will show if the device has been shock loaded, meaning that someone has taken a fall. If the indicator is elongated, the device has been subjected to a fall and cannot be reused. Figure 36 shows an SRD with its components labeled.

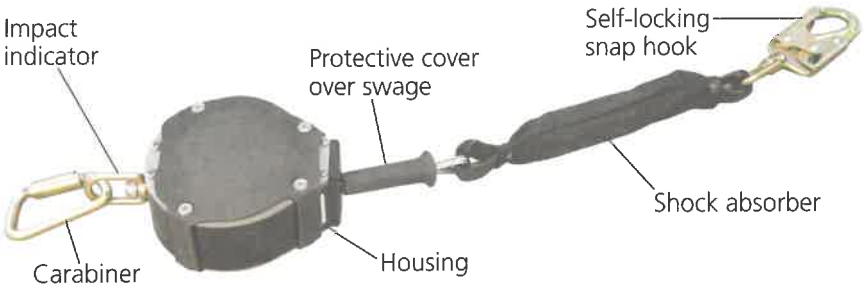


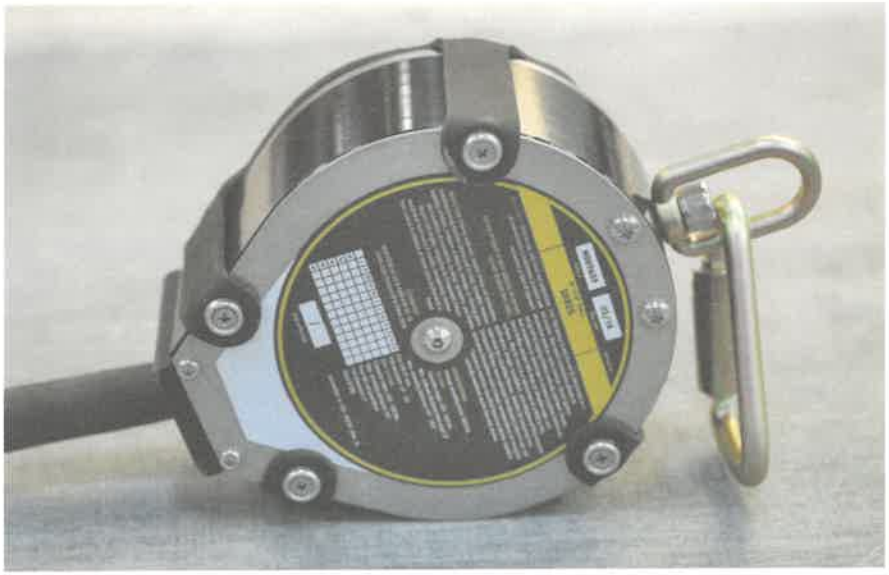
FIGURE 36
SRD with labeled components

TRADE TIP

Inspecting the full length of the self-retracting device's lifeline will ensure that damage that may not normally be visible is found.

Housing The SRD housing and anchoring loop should be inspected for distortion, cracks, and other damage. It is important to make certain all screws and fasteners are tight. SRD housing is shown in Figure 37.

FIGURE 37
SRD housing



SAFETY TIP

Using an SRL on a low-slope roof may prevent the braking mechanism from engaging due to the slow speed of a fall, which could allow a worker to fall over the leading edge.

Lifeline To inspect an SRD lifeline, it should be fully extended and examined for cuts, burns, tears, abrasions, frays, excessive soiling and discoloration, and broken wires. When inspecting a lifeline, any covering over *swage fittings* should be pulled back to allow for inspection. Figure 38 shows a swage fitting on a lifeline being inspected.

FIGURE 38
Inspecting a swage fitting on a lifeline

Braking Mechanism The SRD should be checked to make sure the braking mechanism locks properly. To do this, the lanyard should be pulled on sharply, which should engage the braking mechanism like a vehicle seat belt. If the braking mechanism does not engage, the SRD should be removed from service.

Spring Extension/Retraction SRD spring tension should be checked by pulling the lifeline out fully and then slowly allowing the lifeline to

retract back into the housing. Proper tension must be kept on the device and no slack should be allowed; this will ensure that the lanyard will not bind up inside the housing. An SRD being checked for spring tension is shown in Figure 39.

FIGURE 39
Checking an SRD for spring tension

Self-Locking Snap Hooks A **self-locking snap hook** is a self-closing device with a keeper or latch that will remain closed until manually opened with two consecutive actions by the user. A self-locking snap hook is shown in Figure 40. The device should be closely inspected for hook and eye distortions, cracks, corrosion, or pitted surfaces. The gate should seat without binding and should not be distorted or obstructed. The gate spring should exert enough force to firmly close, and locks must prevent it from opening when closed.

FIGURE 40
Self-locking snap hook

PROCEDURE

How to Properly Inspect a Self-Retracting Device (SRD)

1. Inspect the impact indicator, as shown in Figure 41. If the impact indicator is red, it should immediately be taken out of service and returned to the manufacturer.
2. Check to make sure labels are present and fully legible, as shown in Figure 42.
3. Inspect the housing for distortion, cracks, loose or missing screws, and other damage, and make sure the anchorage point is not distorted or damaged. See Figure 43.
4. Ensure the locks engage when the lifeline is pulled sharply, and that there is no slippage.

(continued)

FIGURE 41
Inspecting the impact indicator

FIGURE 42
Legible labels

FIGURE 43
Inspecting the housing

FIGURE 44
Inspecting the snap hook

PROCEDURE *(continued)*

5. Confirm that the snap hooks or carabiners are free of damage, distortion, or corrosion and are in good working condition. See Figure 44.
6. Pull back the rubber cover to inspect the swage fitting for damage, as shown in Figure 45.
7. Extend the lifeline fully and confirm that it retracts smoothly with no hesitation or slack on the line.
8. Using a gloved hand, check the fully extended lifeline for cuts, burns, chemical damage, abrasions, loose strands, or corrosion. See Figure 46.

FIGURE 45
Swage inspection

FIGURE 46
Inspecting a length of the lifeline

SELF CHECK

1. Explain why it is essential to properly inspect all PFAS equipment before each use.
2. Describe the process of inspecting a full-body harness.
3. Describe the process of inspecting a lanyard.
4. Explain how to properly and fully inspect a self-retracting device (SRD).
5. Why is it especially important to inspect an SRD impact indicator?

4 Donning and Doffing a Full-Body Harness

Donning refers to the act of putting on protective gear such as fall protection equipment, whereas **doffing** refers to the act of taking off such protective gear. The correct donning, doffing, and storage of safety gear is very important and directly related to worker safety.

Donning and Adjusting the Harness

Donning is a critical part of the PFAS process. If a full-body harness is not properly donned, the harness or the PFAS may not function as intended. Before donning a full-body harness, it should be thoroughly inspected as described earlier in this chapter. It is also important that the manufacturer's instructions be checked before beginning the donning process.

To orient the harness, the back of the D-ring should be held to allow the harness to hang; the harness can then be given a slight shake so that the straps and other components fall into place. It is important to ensure that none of the straps are twisted as they are placed on the worker's shoulders. See Figure 47. Since it is difficult for the wearer to see the straps in this position, a second worker should check to ensure that the straps are lying flat.

The leg straps should then be connected one at a time to the buckles on each leg, as shown in Figure 48, and pulled tight. Loose straps will not be effective in the event of a fall, so they must be snug against the worker's body, but not too snug, as this may be uncomfortable and restrict circulation. If the straps have been properly

FIGURE 47
Placing the shoulder straps

FIGURE 48
Connecting the leg straps

FIGURE 49
Checking for fit

FIGURE 50
Connecting the chest strap

FIGURE 51
Proper D-ring location

tightened, a hand should fit snugly between the leg and strap, as shown in Figure 49. The chest strap is then connected across the middle of the chest, as shown in Figure 50.

Full-body harnesses are adjustable and can be made to comfortably fit each worker. For the best fit, the back D-ring should be located between the shoulder blades, as shown in Figure 51. Shoulder straps should be the same length and pulled taut. The harness should feel snug but allow for normal movements such as squatting down, reaching up, and bending over. The following procedure details the process of donning a full-body harness.

SAFETY TIP

Properly adjusting and tightening the straps when donning a harness will decrease the chances of bodily injury if a fall occurs.

PROCEDURE

How to Properly Don a Harness

1. Hold the harness by the back D-ring, as shown in Figure 52.
2. Shake the harness to allow all straps to fall in place.
3. Release the chest, leg, or waist straps if they are buckled.
4. Slide the harness straps over the shoulders and position the D-ring in the middle of the back between the shoulder blades, as shown in Figure 53.
5. Reach between the legs and grab one leg strap. Bring the strap up between the legs and attach it to the buckle, as shown in Figure 54.
6. Repeat step 5 with the second leg strap.
7. Connect the belt, if necessary. See Figure 55.
8. Connect the chest strap, as shown in Figure 56, positioning it across the middle of the chest and tightening it to keep the shoulder straps straight.

(continued)

FIGURE 52
Holding the harness by the D-ring

FIGURE 53
Properly positioned D-ring

FIGURE 54
Buckling the leg strap

FIGURE 55
Buckling the belt

FIGURE 56
Connecting the chest strap

PROCEDURE *(continued)*

9. Tighten and adjust each buckle evenly to keep the harness snug, while allowing a full range of movement. Best practice is to check for tightness by inserting the palm of a hand between the leg and leg strap and then making a fist, as shown in Figure 57. It should not be possible to pull the fist through the leg strap.
10. Place any excess strap webbing into the harness webbing keeper, as shown in Figure 58. Never cut off the excess length.

FIGURE 57
Checking for proper fit

FIGURE 58
Storing excess webbing

Doffing and Storing the Harness

Doffing is essentially the reverse of the donning process, and it should be carried out with the same attention to detail and care. Workers must be careful to avoid damaging straps and other components when doffing and storing a full-body harness.

Storage

Too often, workers will take off their harness at the end of a shift and toss it in the back of a work van, locker, or gang box. Worse yet, harnesses and lanyards may be left lying around a jobsite where they are exposed to rain, heat, freezing temperatures, and direct sunlight. Safety equipment exposed to the elements may be damaged and may not function properly. For the proper care of full-body harnesses and other safety equipment, it must be kept in a clean, cool, dry place to ensure they remain in safe working condition. The storage tips presented in this section should be followed.

Hanging the Harness The harness should be hung so that it does not get crushed, bent, or torn by other objects in the storage area. Sharp tools can slice the nylon and chemicals could cause the material to degrade. Figure 59 shows full-body harnesses properly hung for storage.

Storage Area Safety equipment storage areas should not be exposed to direct sunlight or excess heat. The materials in a full-body harness can be compromised by extended exposure to heat and UV radiation. Extensive exposure to ultraviolet light can cause materials to break down and fail.

FIGURE 59
Properly hung harnesses

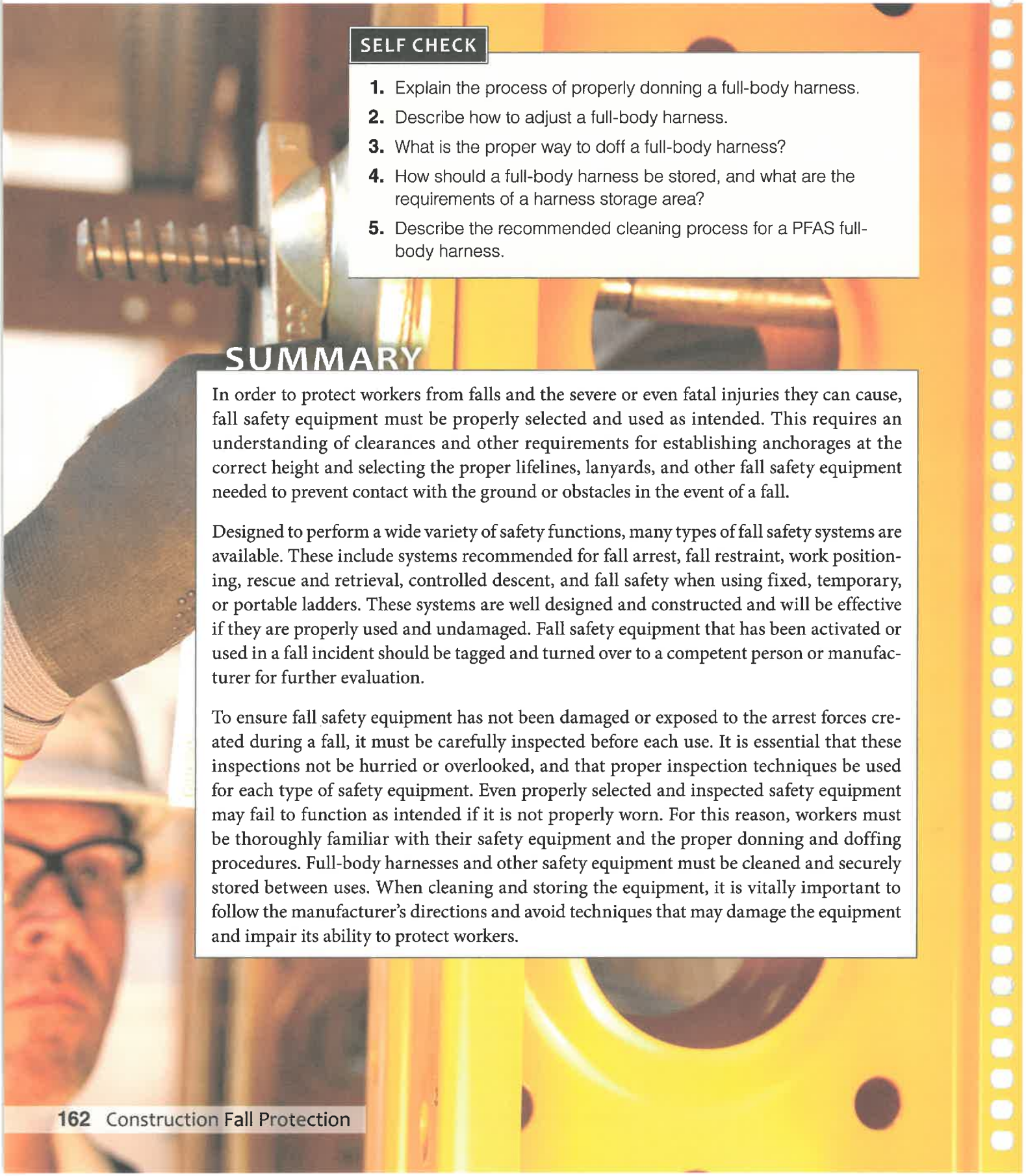
Security Storage security is critical since it is impossible to say what may happen to safety gear that has been stored in an open area or other unsecured place. If the equipment is used by someone without permission during another shift, it may be damaged or require cleaning and will likely need to be readjusted before it can be used.

Cleaning

Full-body harnesses and other safety equipment should be kept clean. Construction work exposes harnesses to grime and a wide variety of chemical substances, which means they must be cleaned on a regular basis. When cleaning a harness, it is always best to follow the manufacturer's instructions and recommendations and heed all warnings concerning harsh cleaners or scrubbing techniques. In some cases, the following methods can be used to clean a full-body harness:

- A damp sponge, and warm water only, can be used to wipe away any residue on straps and buckles.
- Mild dish soap or laundry detergent can be used to work up a lather on the straps. Cleaners containing chlorine bleach or abrasives must be avoided.

- The lather should be rinsed from the straps with a sponge and clean water. Harnesses or lanyards should not be soaked, as this could damage them.
- The equipment should be wiped down and hung out to dry.



SELF CHECK

1. Explain the process of properly donning a full-body harness.
2. Describe how to adjust a full-body harness.
3. What is the proper way to doff a full-body harness?
4. How should a full-body harness be stored, and what are the requirements of a harness storage area?
5. Describe the recommended cleaning process for a PFAS full-body harness.

SUMMARY

In order to protect workers from falls and the severe or even fatal injuries they can cause, fall safety equipment must be properly selected and used as intended. This requires an understanding of clearances and other requirements for establishing anchorages at the correct height and selecting the proper lifelines, lanyards, and other fall safety equipment needed to prevent contact with the ground or obstacles in the event of a fall.

Designed to perform a wide variety of safety functions, many types of fall safety systems are available. These include systems recommended for fall arrest, fall restraint, work positioning, rescue and retrieval, controlled descent, and fall safety when using fixed, temporary, or portable ladders. These systems are well designed and constructed and will be effective if they are properly used and undamaged. Fall safety equipment that has been activated or used in a fall incident should be tagged and turned over to a competent person or manufacturer for further evaluation.

To ensure fall safety equipment has not been damaged or exposed to the arrest forces created during a fall, it must be carefully inspected before each use. It is essential that these inspections not be hurried or overlooked, and that proper inspection techniques be used for each type of safety equipment. Even properly selected and inspected safety equipment may fail to function as intended if it is not properly worn. For this reason, workers must be thoroughly familiar with their safety equipment and the proper donning and doffing procedures. Full-body harnesses and other safety equipment must be cleaned and securely stored between uses. When cleaning and storing the equipment, it is vitally important to follow the manufacturer's directions and avoid techniques that may damage the equipment and impair its ability to protect workers.

Selecting, Inspecting, and Wearing Fall Protection Equipment

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. Fall _____ is the height at which a worker must attach a lifeline or lanyard to an anchorage in order to avoid contact with a lower level or obstacle during a fall.

2. The two most important factors influencing a free fall and the force with which an object strikes a surface are ____.
   a. size and composition
   b. speed and weight
   c. speed and surface tension
   d. acceleration and shape

3. In just .61 seconds, a falling worker would travel 6′-0″, reach a speed of 13.3 mph, and strike the ground or other solid surface with a force equal to about ____.
   a. 1,200 pounds
   b. 1,800 pounds
   c. 2,400 pounds
   d. 3,600 pounds

4. The _____-_____ distance is the distance the worker travels from the moment the fall occurs to the moment the fall arrest system is activated.

5. A work-positioning harness is used to hold a construction professional in place while keeping the worker hands-free to perform tasks and that must limit free fall to ____.
   a. 1′-0″ or less
   b. 2′-0″ or less
   c. 3′-0″ or less
   d. 5′-0″ or less

6. Any component of a fall safety system that fails to pass inspection, shows signs of wear, or is damaged in any way must be removed from service immediately, tagged, and turned over to a competent person for further evaluation. (True; False)

7. Webbing is a fabric used on fall protection equipment and components such as full-body harnesses and lanyards. (True; False)

8. It is important to make sure all _____ are in place and none are missing or loose.

9. A(n) _____ should be inspected by beginning at one end and working to the other while slowly rotating the device so that its entire circumference is checked.
   a. belt buckle
   b. anchorage
   c. lanyard
   d. full-body harness

10. To make sure that _____-_____ snap hooks function properly, they should be examined closely for hook and eye distortions, cracks, corrosion, weld marks, or pitted surfaces.

11. A _____ is a high-tensile alloy steel connector that has a locking gate and is used primarily in specialized work such as scaffold erection and high-angle rescue.
   a. carabiner
   b. tongue
   c. buckle
   d. hook and loop

12. A retractable lanyard that uses inertia to activate a braking mechanism is referred to as a(n) _____.
   a. inertial retractor (IR)
   b. retractable lifeline (RLL)
   c. manually retracting device (MRD)
   d. self-retracting device (SRD)

13. A shock-absorbing stretch lanyard should be examined as if it were a web lanyard. (True; False)

14. If the indicator is _____, the SRD has been subjected to a fall and activated and cannot be reused.

15. Essentially the reverse of the donning process, _____ is the act of taking off protective gear such as fall protection equipment.

16. When evaluating fall clearances, a competent person will take into consideration free-fall distances and all _____ such as I-beams, jobsite equipment, and impalement hazards.

17. _____ are safety systems intended to prevent workers from reaching the margins of buildings, scaffolds, and leading edges where they will be exposed to free-fall hazards.
   a. Self-rescue equipment
   b. Fall restraint systems
   c. Fall arrest systems
   d. Lanyard and lifeline systems

18. _____ are used primarily for confined space applications where workers must enter tanks, manholes, and similarly restricted environments where assistance must reach them from above in the event of an emergency.
    a. Suspension/personnel riding systems
    b. Descent/rescue harnesses
    c. Lanyard/lifeline harnesses
    d. Elevated platform systems

19. A(n) _____ is used to hold a worker in place while allowing the worker to work hands-free to perform tasks.
    a. positioning harness
    b. fall arrest systems
    c. lanyard/lifeline systems
    d. elevated platform systems

20. For the best fit of a full-body harness, the back _____-
    _____ should be located between the shoulder blades.

WORKSHEET 1

Matching Terms

Instructions Match the term with the correct definition.

_____ 1. Free-fall distance

_____ 2. Webbing

_____ 3. Doffing

_____ 4. Self-locking snap hooks

_____ 5. Donning

_____ 6. Impact indicator

_____ 7. Fall clearance

A. Self-closing device with a keeper or latch that will remain closed until manually opened with two consecutive actions by the user

B. Height at which a worker must attach to an anchorage to avoid contact with a lower level

C. Visual device that shows the fall arrest system has been subjected to a fall

D. Woven fabric used on fall protection equipment components such as full-body harnesses and lanyards

E. Act of taking off protective gear such as fall protection equipment

F. Act of putting on protective gear such as fall protection equipment

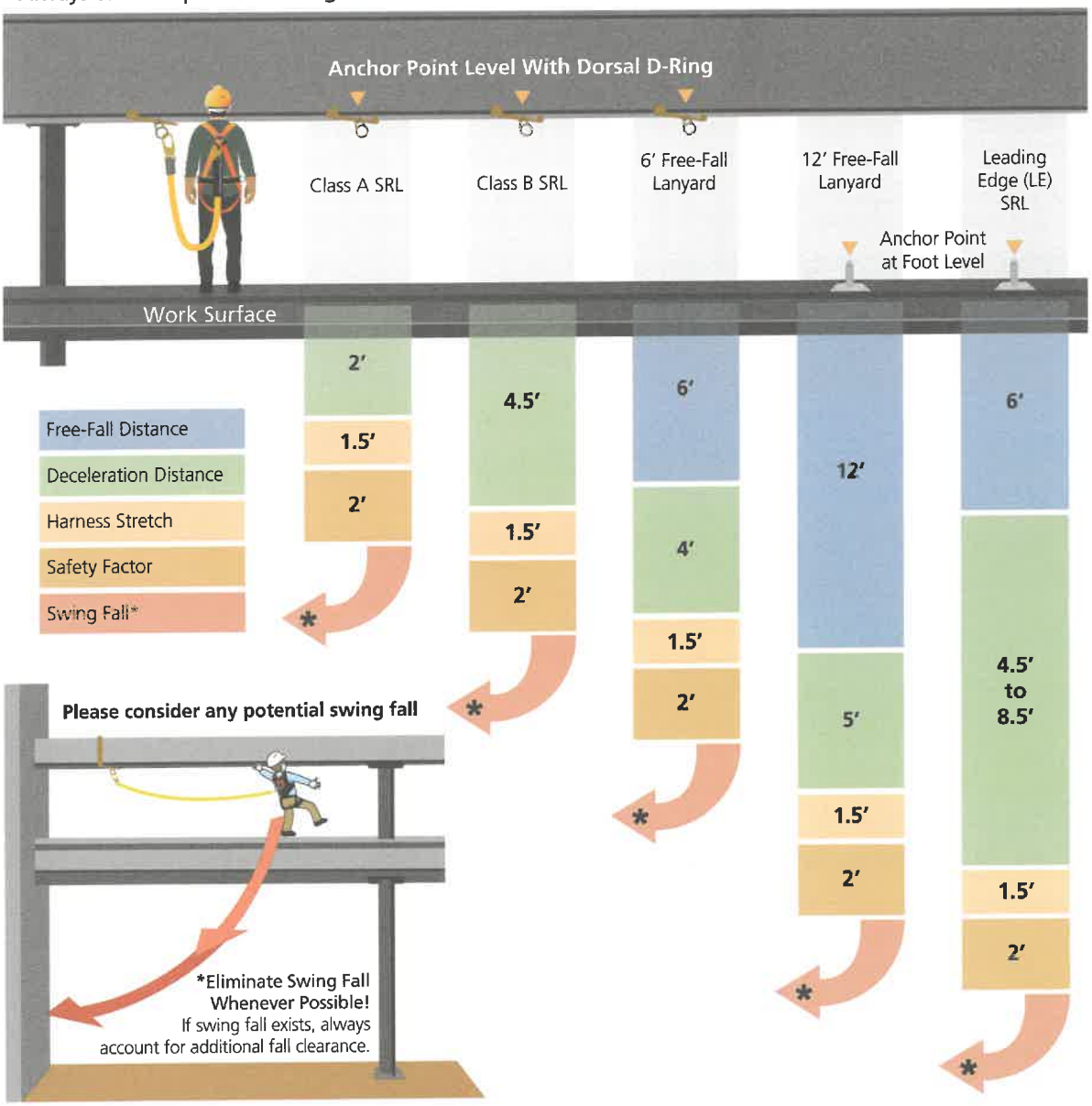
G. Distance a person travels from the moment a fall occurs to the moment the fall arrest system is activated

WORKSHEET 2

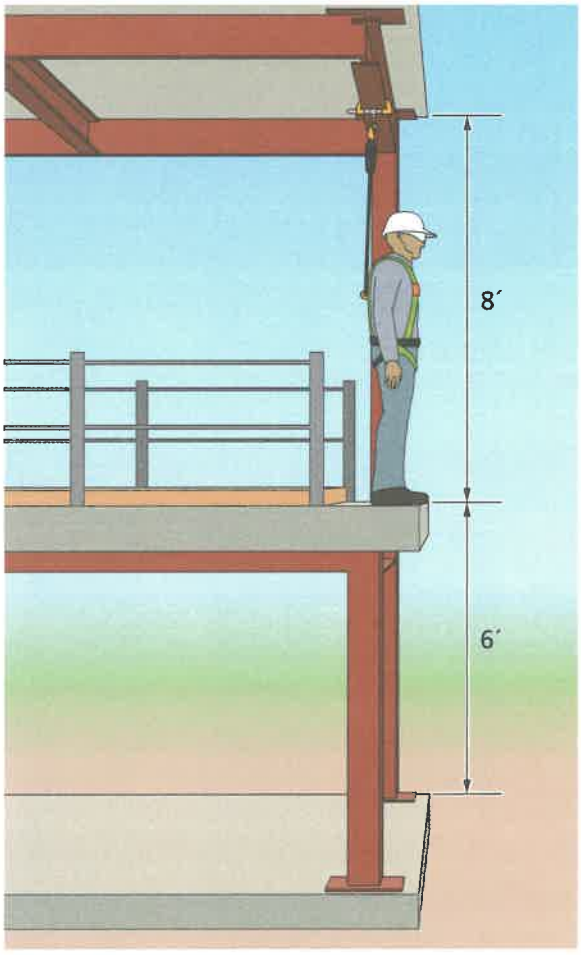
Fall Clearance

Instructions Use the fall clearance diagram below to answer the questions for each of the following graphics. Place your answer in the blank provided.

Fall clearance calculation shown based on standing worker falling directly in line with anchor point. Always consider potential swing fall and other hazards when calculating fall clearance.



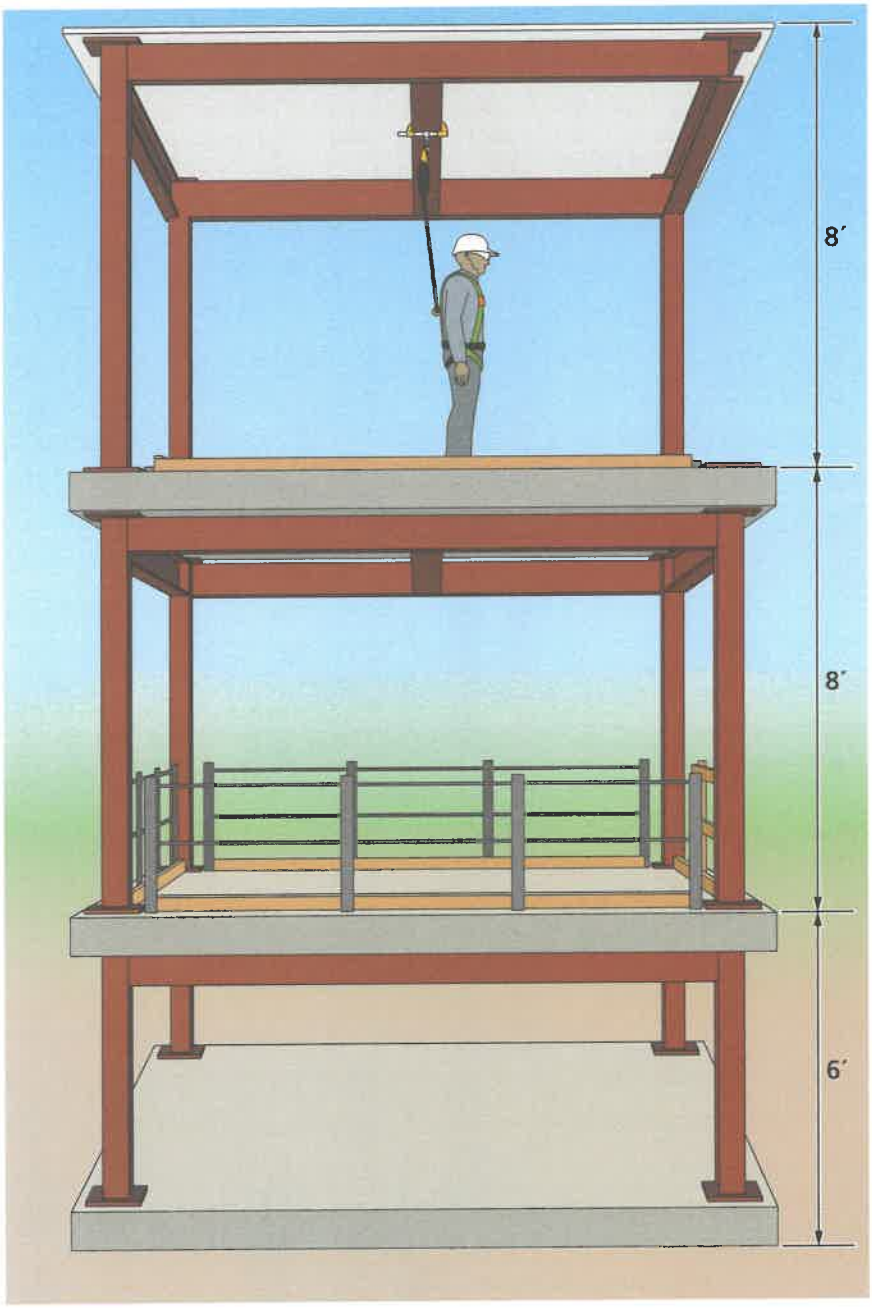
Fall Clearance (continued)



1. The worker depicted here is using a Class A SRL with an anchorage point directly over their head. Will the fall arrest system in use prevent the worker from striking the ground?

_____

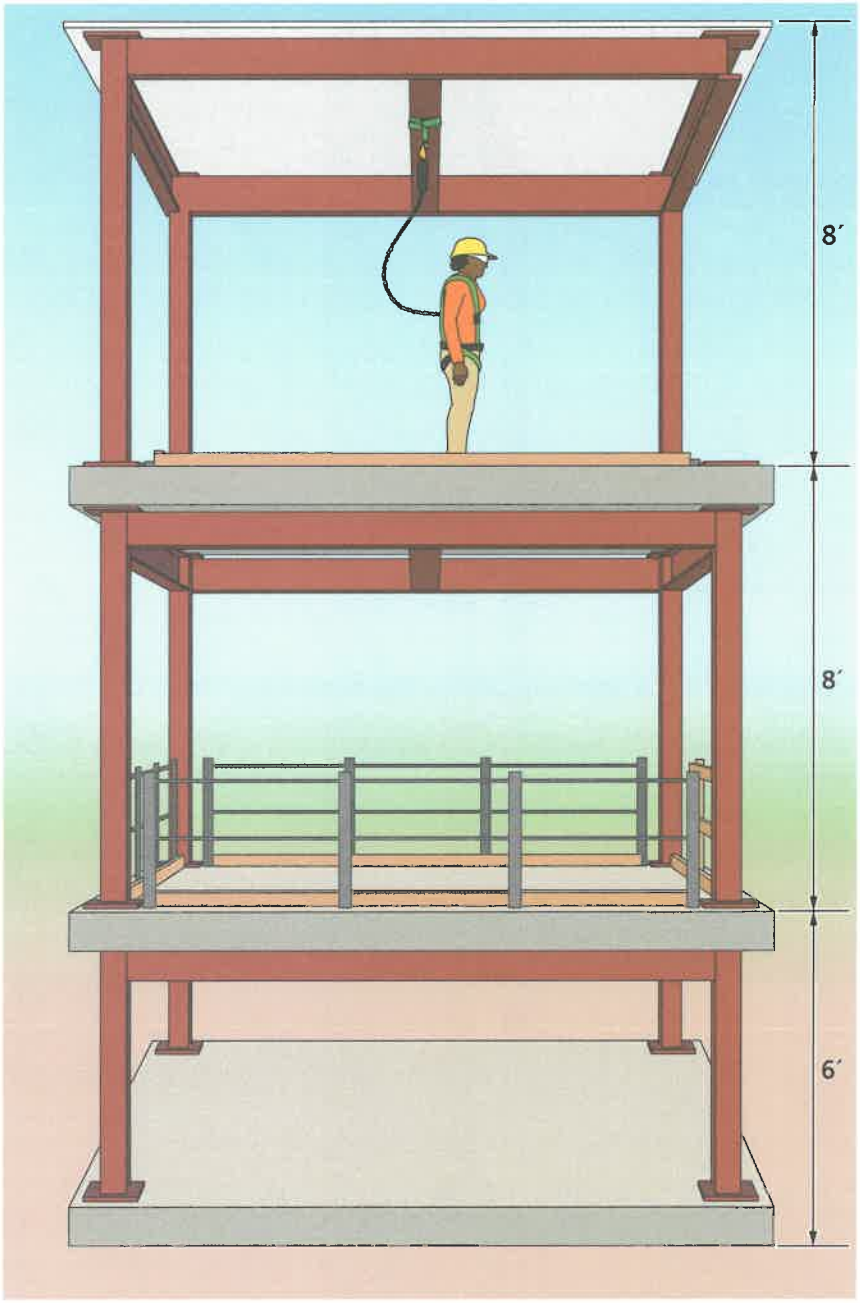
Fall Clearance (continued)



2. The worker is using a Class B SRL with an anchorage point directly over their head. Will the fall arrest system in use prevent the worker from striking the lower level?

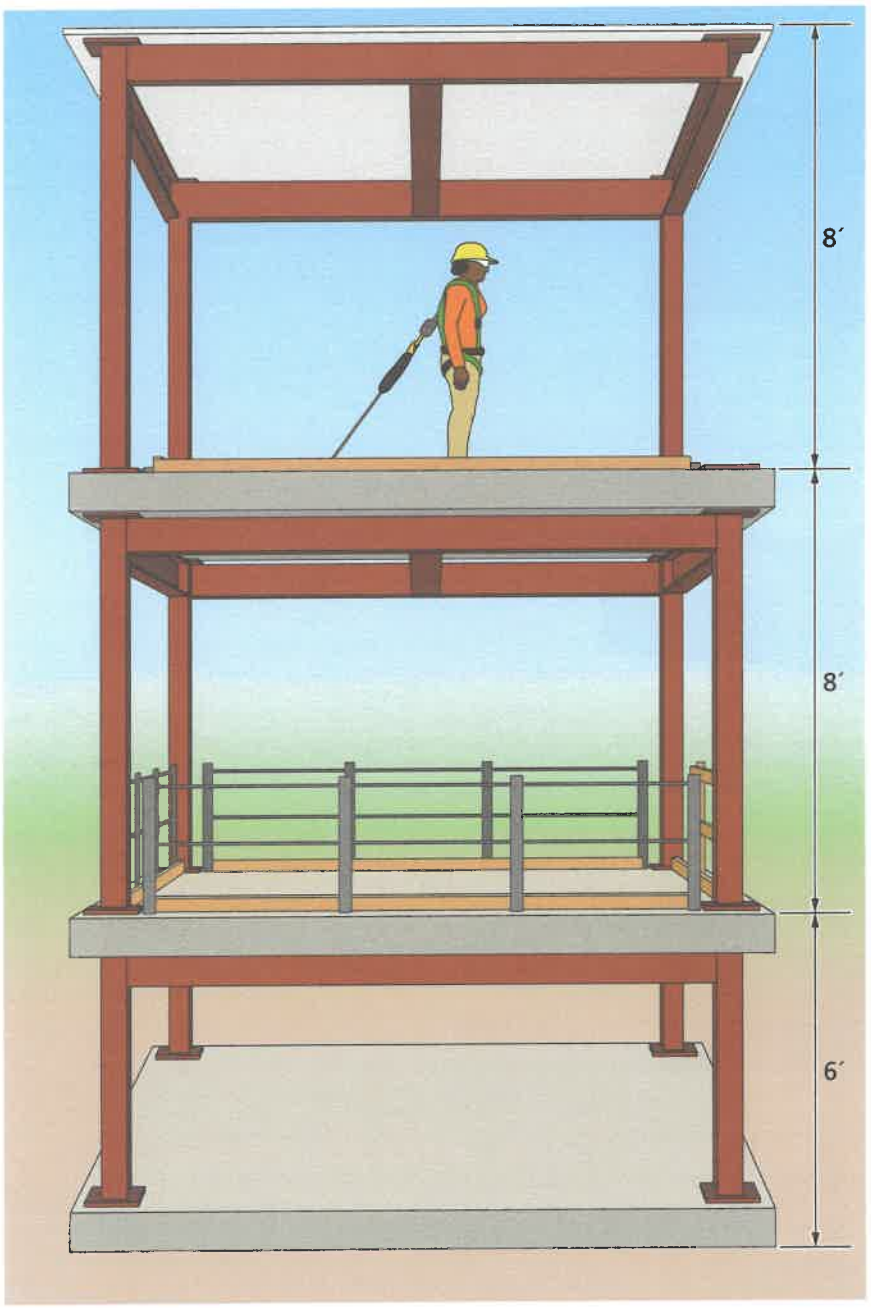
_____

Fall Clearance (continued)



3. The worker is using a 6′-0″ free-fall shock-absorbing lanyard that is connected to an approved overhead anchorage point that is directly over their head. Will the fall arrest system in use prevent the worker from striking the lower level? _____

Fall Clearance (continued)

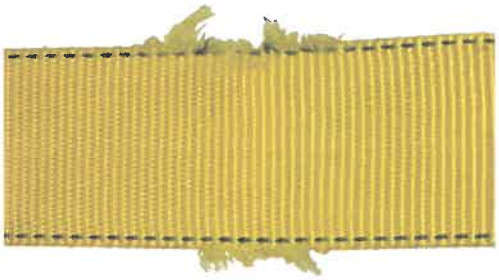


4. The worker is using a 6′-0″ free-fall shock-absorbing lanyard that is connected to an approved anchorage point at floor level. Will the fall arrest system in use prevent the worker from striking the lower level? _____

WORKSHEET 3

Inspecting Personal Fall Arrest Systems (PFAS)

Instructions Inspect the following components and describe the defect and why the component is unsafe to use. Place your answer in the space provided.

1. 

2. 

3. 

4. 

Inspecting Personal Fall Arrest Systems (PFAS) (continued)

5.

6.

7.

8.

Inspecting Personal Fall Arrest Systems (PFAS) (continued)

9.

10.

11.

WORKSHEET 3

Inspecting Personal Fall Arrest Systems (PFAS) (continued)

12.

_____

_____

13.

_____

_____

14.

_____

_____

WORKSHEET 4

Inspections and Documentation

Instructions Use the inspection forms provided below to perform an inspection of the various components of a fall protection system. Begin by filling in the section for the model, date, serial number, and lot number for the component provided by your instructor. Carefully examine the components and fill in the remainder of the form for each of them.

Full-Body Harnesses

Harness Model: _____ Manufacture Date: _____

Serial Number: _____ Lot Number: _____

Comments: _____

_____

General Factors	Accepted/Rejected	Supportive Details or Comments
1. Hardware: Includes D-rings, buckles, keepers, and back pads. Inspect for damage, distortion, sharp edges, burrs, cracks, and corrosion.	_____ Accepted _____ Rejected	
2. Webbing: Inspect for cuts, burns, tears, abrasion, frays, excessive soiling, and discoloration.	_____ Accepted _____ Rejected	
3. Stitching: Inspect for pulled or cut stitches.	_____ Accepted _____ Rejected	
4. Synthetic Rope: Inspect for pulled or cut yarns, burns, abrasion, knots, excessive soiling, and discoloration.	_____ Accepted _____ Rejected	
Overall Disposition	_____ Accepted _____ Rejected	Inspected By: _____ Date Inspected: _____

WORKSHEET 4

Inspections and Documentation (continued)

Lanyards

Lanyard Model: _____ Manufacture Date: _____

Serial Number: _____ Lot Number: _____

Comments: _____

_____

General Factors	Accepted/Rejected	Supportive Details or Comments
1. Hardware: Includes snap hooks, carabiners, adjusters, keepers, thimbles, and D-rings. Inspect for damage, distortion, sharp edges, burrs, cracks, and corrosion.	_____ Accepted _____ Rejected	
2. Webbing: Inspect for cuts, burns, tears, abrasion, frays, excessive soiling, and discoloration.	_____ Accepted _____ Rejected	
3. Stitching: Inspect for pulled or cut stitches.	_____ Accepted _____ Rejected	
4. Synthetic Rope: Inspect for pulled or cut yarns, burns, abrasion, knots, excessive soiling, and discoloration.	_____ Accepted _____ Rejected	
5. Wire Rope: Inspect for pulled or cut yarns, burns, abrasion, knots, excessive soiling, and discoloration.	_____ Accepted _____ Rejected	
6. Energy-Absorbing Component: Inspect for elongation, tears, and excessive soiling.	_____ Accepted _____ Rejected	
7. Labels: Inspect, make certain all labels are securely held in place and legible.	_____ Accepted _____ Rejected	
Overall Disposition	_____ Accepted _____ Rejected	Inspected By: _____ Date Inspected: _____

WORKSHEET 4

Inspections and Documentation (continued)

Tie-Off Adaptors

Tie-Off Adaptor Model: _____ Manufacture Date: _____

Serial Number: _____ Lot Number: _____

Comments: _____

_____

General Factors	Accepted/Rejected	Supportive Details or Comments
1. Hardware: (Includes D-rings). Inspect for damage, distortion, sharp edges, burrs, cracks, corrosion, and proper operation.	_____ Accepted _____ Rejected	
2. Webbing: Inspect for cuts, burns, tears, abrasion, frays, excessive soiling, and discoloration.	_____ Accepted _____ Rejected	
3. Stitching: Inspect for pulled or cut stitches.	_____ Accepted _____ Rejected	
4. Labels: Inspect, make certain all labels are securely held in place and legible.	_____ Accepted _____ Rejected	
Overall Disposition	_____ Accepted _____ Rejected	Inspected By: _____ Date Inspected: _____

WORKSHEET 4

Inspections and Documentation (continued)

Self-Retracting Lifelines

Self-Retracting Lifeline Model: _____ Manufacture Date: _____

Serial Number: _____ Lot Number: _____

Comments: _____

_____

General Factors	Accepted/Rejected	Supportive Details or Comments
1. Impact Indicator: Inspect indicator for activation (rupture of red stitching, elongated indicator, etc.)	____ Accepted ____ Rejected	
2. Screws/Fasteners: Inspect for damage and make certain all screws and fasteners are tight.	____ Accepted ____ Rejected	
3. Housing: Inspect for distortion, cracks, and other damage. Inspect anchoring loop for distortion and damage.	____ Accepted ____ Rejected	
4. Lifeline: Inspect for pulled or cut yarns, burns, tears, abrasion, frays, excessive soiling and discoloration, and broken wires (see impact indicator section).	____ Accepted ____ Rejected	
5. Locking Action: Inspect for proper lock-up of brake mechanism.	____ Accepted ____ Rejected	
6. Retraction/Extension: Inspect for spring tension by pulling lifeline out fully and allowing it to retract fully (no slack).	____ Accepted ____ Rejected	
7. Hooks/Carabiners: Inspect for physical damage, corrosion, proper operation and markings (see separate checklist/log for hooks and carabiners).	____ Accepted ____ Rejected	
8. Reserve Lifeline: Inspect reserve lifeline retention systems for deployment.	____ Accepted ____ Rejected	
9. Labels: Inspect, make certain all labels are securely held in place and legible.	____ Accepted ____ Rejected	
Overall Disposition	____ Accepted ____ Rejected	Inspected By: _____ Date Inspected: _____

WORKSHEET 4

Inspections and Documentation (continued)

Anchorage Points

Anchorage Plate Model: _____ Manufacture Date: _____

Serial Number: _____ Lot Number: _____

Comments: _____

_____

General Factors	Accepted/Rejected	Supportive Details or Comments
1. Physical Damage: Inspect for cracks, sharp edges, burrs, deformities, and locking operation.	_____ Accepted _____ Rejected	
2. Excessive Corrosion: Inspect for corrosion which affects the operation and/or strength.	_____ Accepted _____ Rejected	
3. Fasteners: Inspect for corrosion, tightness, damage, and distortion. If welded, inspect weld for corrosion, cracks, and damage.	_____ Accepted _____ Rejected	
4. Markings: Inspect, make sure certain marking(s) are legible.	_____ Accepted _____ Rejected	
Overall Disposition	_____ Accepted _____ Rejected	Inspected By: _____ Date Inspected: _____

WORKSHEET 4

Inspections and Documentation (continued)

Hooks/Carabiners

Hook/Carabiner Model: _____ Manufacture Date: _____

Serial Number: _____ Lot Number: _____

Comments: _____

_____

General Factors	Accepted/Rejected	Supportive Details or Comments
1. Physical Damage: Inspect for cracks, sharp edges, burrs, deformities, and locking operation.	_____ Accepted _____ Rejected	
2. Excessive Corrosion: Inspect for corrosion which effects the operation and/or strength.	_____ Accepted _____ Rejected	
3. Markings: Inspect, make sure certain marking(s) are legible.	_____ Accepted _____ Rejected	
Overall Disposition	_____ Accepted _____ Rejected	Inspected By: _____ Date Inspected: _____

WORKSHEET 5

Donning a Harness

Instructions The figures below are out of order. Number each figure to indicate the proper sequence for donning a harness.

CHAPTER 6

Dropped-Object Hazard Control

INTRODUCTION

Every day, construction site personnel are confronted with two very different, but nonetheless dangerous, types of fall threats. One of these is the chance that they themselves will fall from elevation, slip through a hole or gap in a working surface, or stumble over some unseen object in a cluttered walkway. The other is the possibility of being struck and injured by tools, materials, or debris falling from upper levels. Hazards can be eliminated in several ways, including through the use of debris nets.

This chapter explains other methods of eliminating or controlling the hazard created by falling objects, including administrative controls, the use of hard hats and other personal protective equipment (PPE), the installation of toeboards and canopies, and the proper anchoring and tethering of tools.

CONTENTS

OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. Describe measures that can be taken to eliminate dropped-object accidents.
2. Describe a tool anchoring system and explain how it is used.
3. List three types of tethers.
4. Describe three types of anchor points.
5. Explain the importance of weight when deciding how to anchor a tool.
6. Explain how tools without built-in tool anchorage points can be retrofit.
7. Explain the Foreign Material Exclusion (FME) process and why these precautions are often necessary.

KEY TERMS

Key Terms are in order of appearance.

Foreign Material Exclusion (FME) process used to prevent debris and other objects from getting into any area where they would pose a safety hazard or damage equipment

tool lanyard flexible length of rope or strap with a connector at each end that can be fastened to a tool tether and a tool anchorage point

tool anchorage point secure point of attachment, such as a person or fixed structure

tool tethering point manufactured location on a tool for fastening a lanyard

retrofit installation of a tethering point on a tool manufactured without one

1 Ensuring a Safe Work Environment

Construction is an inherently dangerous process, and safety should be the first and foremost consideration of everyone who ventures onto a construction site. Workers must be aware of a wide range of hazards, any one of which may lead to a disabling or perhaps even fatal injury. Construction site personnel may be aware of many obvious hazards such as moving vehicles, active machinery, open pits, or high ledges, but they are less likely to be aware of falling tools. When a worker is unexpectedly struck on the head by a falling tool, the injury caused may prove fatal.

Many have heard of the New Jersey construction site incident in which a worker was killed by a tape measure. The victim was an independent trucking company contractor who was making a Sheetrock® delivery. Just as a worker dropped a tape measure from 50 stories up, the victim leaned out of the window, perhaps to ask a question. The tape measure ricocheted off of a piece of equipment 10 feet away and struck the victim in the side of the head. The worker was taken to the hospital where he was pronounced dead an hour after the accident. Although he was not wearing a hard hat at the time, it is not clear whether that would have saved him since the object had been deflected and hit him from the side.

TRADE TIP

Being struck by falling objects is one of the leading causes of construction fatalities. When falling from height, even small objects can cause serious or fatal injuries.

According to OSHA records, more than 50,000 workers and others were struck by falling objects on jobsites during a recent recording period. Not all of these incidents were fatal, but more than a few proved deadly and many others led to severe or even disabling injuries and hospitalizations. Interestingly, OSHA statistics show that the people below, who were likely to be struck by a dropped object, were not the only ones endangered by them. The worker who dropped the tool was also in danger. When someone drops a tool or other object, the natural response may be to reach or lunge after it to try and recover the lost item. This may cause the worker to lose balance and fall. Dropped objects present a serious safety threat that demands close attention and carefully planned and executed control measures.

SAFETY TIP

Accidentally dropping a tool from height poses two dangers: first, the falling tool has the potential to hit someone; secondly, when we drop something we have the inclination to catch it, which can be a dangerous reflex that could cause a worker to fall after their tool.

Preventive Measures

Debris nets and properly used PPE, such as hard hats, can help protect workers and equipment from falling objects, or at least limit the damage they may cause. Prevention is an effective method of controlling fall hazards, and the same is true of dealing with the threat of dropped objects. A tool or other object that never falls cannot strike and injure anyone below and cannot cause a worker to lunge after it and fall.

In addition to commonsense care and caution, a variety of highly effective preventive measures can be taken to stop dropped-object accidents before they occur. These include the use of fully decked platforms, guardrails, toeboards, and tool anchoring systems. Toeboards intended to prevent tools and materials from falling are shown in Figure 1. These methods are described in detail later in this chapter.

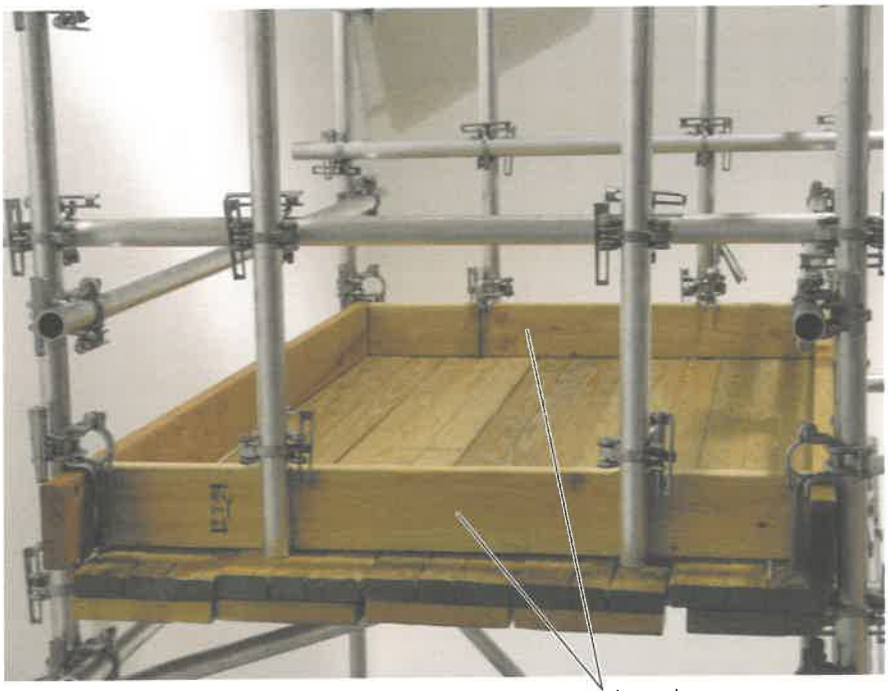


FIGURE 1
Installed toeboards for the prevention of dropped objects

Safe Work Practices

Workers can make their most important contribution to their own safety and the safety of others by following safe work practices. These are especially important for the prevention of accidents and injuries caused by dropped and falling tools, materials, and debris. Such practices require only a little extra foresight, care, and effort. For instance, when tools will be used at heights, it is a good practice to check for any gaps or openings in floors or substrates that may allow the tools to slip through and fall. If possible, these should be closed or covered. To alert project personnel or the public that people are working above, barricades or warning signs can be placed in areas that may be exposed to falling objects. Good housekeeping is also important, and tools should be properly stored after use to ensure they do not fall due to wind, vibration, or incidental contact with other

FIGURE 2
Self-closing tool bag

workers. Anyone working at heights with tools should observe the following practices:

- Use tool bags, such as the one shown in Figure 2, to secure tools and materials and prevent them from falling.
- Barricade hazardous areas and post warning signs, such as the one shown in Figure 3.
- Use toeboards and guardrails to prevent objects from falling. See Figure 4.
- Use screens, debris nets, catch platforms, or canopies when toeboards are not sufficient to catch or deflect falling objects. Figure 5 shows screens and debris nets.

FIGURE 3
Falling object warning sign

FIGURE 4
Toeboards and guardrails

FIGURE 5
Screens and debris nets

SAFETY TIP

If any tools or materials will be placed on a raised platform, toeboards must be installed to prevent them from falling and injuring workers below.

Workers are just as likely to be threatened by falling objects as they are to cause an accident by dropping a tool or other object themselves. Special care must be taken when walking or working below upper levels where work is in progress or in any environment that may place a worker at risk of being struck by a falling object. To minimize the risk of being struck or injured, workers should take the following precautions:

- Always remain alert within the working environment.
- Limit the time spent in areas that may be exposed to falling objects.
- Observe and follow all warning signs, barricades, controlled access zones, and flagged areas.
- Be aware of overhead activities when walking under elevated walkways.
- Be aware of activities below when walking on elevated walkways.

2 Controlling Dropped-Object Hazards

To keep workers safe, dropped-object hazards must be properly controlled and monitored. This requires the use of a variety of safety measures and techniques. Some of these safety measures are intended to protect vulnerable personnel, while others are used to prevent tools and other objects from falling in the first place. For example, the use of fully decked platforms, guardrails, toeboards, and mesh netting may stop a dropped-object accident before it happens.

SAFETY TIP

Never leave a tool unattended near an unprotected leading edge where it could accidentally fall and injure someone.

Identifying Dropped-Object Hazards

It is essential to carefully inspect all work areas where a dropped-object incident can occur. This should be done before work begins and repeated on a regular basis as a project moves forward. Likely hazards might include areas where mobile elevating work platforms (MEWPs) will be used or where work will be done on scaffold platforms or other elevated surfaces. However, efforts should be made to identify less obvious hazards as well. For instance, wrenches or other tools placed near a ledge or on the side of a piece of equipment may pose significant threats to workers below. Figure 6 shows an example of an often overlooked dropped-object hazard. Identifying both obvious and less noticeable dropped-object hazards can greatly increase jobsite safety, especially if the hazards are immediately eliminated or marked to reduce worker exposure.

FIGURE 6
Overlooked dropped-object hazard

Eliminating Dropped-Object Hazards

The most effective way to prevent dropped-object accidents and injuries is to ensure that hazards are eliminated before

SAFETY TIP

Practice good housekeeping. Pick up debris and keep the work area clear to prevent a dropped-object hazard and help protect anyone working below.

they can cause any harm. Tools and materials should be removed from MEWPs, scaffold platforms, and elevated surfaces whenever they are not in use or needed. Debris should never be left where it can fall, and should be cleared away frequently from elevated areas. Removing objects that can pose a hazard to people working below is a highly effective method for preventing a dropped-object incident. The establishment of barricades and controlled access zones (CAZs) below upper levels and elevated work surfaces will help keep personnel away from areas where they might be struck by a falling tool or piece of construction material. The use of tethers or anchors for tools and objects that are being used on an elevated work level is an effective method of preventing dropped-object accidents.

Toeboards

Toeboards that have been properly placed along the perimeter of scaffold platforms and other elevated work surfaces can prevent countless accidents by ensuring that tools, materials, and other objects do not slide or roll over the edge. Regulations and standards have been developed by OSHA and OH&S to govern the placement and use of toeboards. For instance, toeboards must be placed along the edges of all overhead walking or working surfaces above areas where workers or personnel may be endangered by falling objects. Toeboards must be capable of withstanding forces of at least 50 pounds applied in any downward or outward direction at any point. Toeboards must be at least 3 ½″ high, according to OSHA, and 5 ½″ high, according to OH&S, from their top edge to the level of the walkway or working surface. Also, they must have no more than ¼″ clearance from the working surface to the lower edge of the toeboard. The working surface must be solid and have no openings larger than 1″ in its greatest dimension. If tools, equipment, or materials are piled higher than the top edge of a toeboard, as shown in Figure 7, paneling or mesh netting must be erected from the walkway, working surface, or toeboard to the top of a guardrail system's top rail or midrail, for a distance sufficient to protect workers below.

FIGURE 7
Piled tools and materials

Canopies

Canopies are designed to provide overhead protection from falling objects, and are used when workers or pedestrians must pass underneath a work area. Canopies, often referred to as sidewalk canopies, offer a protective reinforced roof-like covering for sidewalks and other pedestrian passageways. Canopies are typically constructed with the use of scaffolding equipment. However, they must be strong enough to prevent collapse or penetration when struck by a falling object. Figure 8 shows a protective canopy.

Since the safety of workers and the general public is involved, regulations related to the use of sidewalk canopies are very strict. For this reason, it is always important that local, state, provincial, or federal regulation be checked before canopies are installed. Depending on how the canopies are used and the length of the passageway through the scaffold, it may

FIGURE 8
Canopy

be necessary to install lighting for pedestrians. Figure 9 shows a scaffold passageway with lighting. In some cases, it may be necessary to erect barricades around passageways to protect pedestrians from vehicular traffic. It is also important to install toeboards on platforms above passageways and to keep passageways free of protruding objects and sharp edges that may injure workers or pedestrians.

FIGURE 9
Lighted pedestrian passageway

Foreign Material Exclusion (FME)

Anytime equipment is opened, the opening must be covered to prevent foreign objects from getting into the machinery. See Figure 10. Outside debris and other objects can be prevented from entering and damaging equipment

FIGURE 10
Placing an FME cover

or creating a hazard using a process known as **Foreign Material Exclusion** (**FME**), which is a set of standardized procedures used to make sure stray tools and debris are kept out of machinery. One example of an FME procedure is the use of an itemized tool and equipment list.

This itemized checklist identifies all tools and equipment taken into the sensitive area and is used to verify that they are removed once the work is complete. FME procedures are used to prevent a possibly catastrophic failure that could occur if equipment were used with foreign material inside. For example, a wrench left inside the rotor of a steam turbine might severely damage the rotor and eventually cause a destructive and costly breakdown. In some instances, it could cause the machinery to explode and injure workers in the area.

According to FME procedures, anyone working over open or vulnerable equipment should have their tools tied off or tethered. The tool tether will be attached to a lanyard that is attached to the worker or a stationary object to prevent the tool from falling into the equipment if it is dropped. Before working in designated FME zones, such as the one shown in Figure 11, workers are required to empty their pockets of any personal effects such as jewelry, cell phones, and all other loose articles. Workers are required to prepare a checklist to ensure everything is accounted for when they leave the area. The checklist may include work items such as tools, replaced parts, nuts, bolts, materials, and similar items.

FIGURE 11
FME zone

Whenever an item is dropped in an FME zone, the incident must be reported immediately. If the dropped item cannot be immediately retrieved, the worker who dropped it should remain nearby to verify the point of entry. Knowing the correct point of entry will make it easier for the person attempting to retrieve the item to locate and remove it. The point of entry may be marked or labeled for accuracy.

If an item is dropped into sensitive equipment or an FME zone and cannot be immediately retrieved, it is added to a *drop list* that is kept in a designated location. The list serves as a reminder that there is a foreign object in the equipment that must be removed as soon as possible. The drop list entry should include a description of the item dropped, where it was dropped, who dropped it, when it was dropped, and when and by whom it was finally retrieved. If the item is damaged, it should be removed from service.

Safety Hard Hats and PPE

As with other types of work-related accidents, personal protective equipment (PPE) is a worker's last line of defense against the severe and possibly fatal injuries that may be caused by falling objects. It is important to remember, however, that PPE can only protect against injuries if it is properly used.

Perhaps the most important piece of PPE a worker is likely to use on a construction site is a safety hard hat. According to OSHA regulations, hard hats must have a hard shell with a properly fitting, shock-absorbing lining. Anyone working in areas where tools and machinery are in use or materials and other objects are placed overhead must wear a hard hat. The hat's hard shell and lining are intended to reduce the force of impact and protect the head and other parts of the upper body should they be struck by a flying or falling object. Figure 12 shows a jobsite with workers wearing protective hard hats. Workers should always wear hard hats in the following situations:

- working below other workers who are using tools and materials
- working around or under conveyor belts carrying parts or materials
- working below machinery or processes that might cause material or objects to fall
- working around or under scaffolds or other overhead structures
- working around objects suspended by overhead cranes

SAFETY TIP

Workers should inspect their hard hats for any cracks, dents, or signs of deterioration.

TRADE TIP

Hard hats should fit snugly on your head and not come loose during normal movements or work activities.

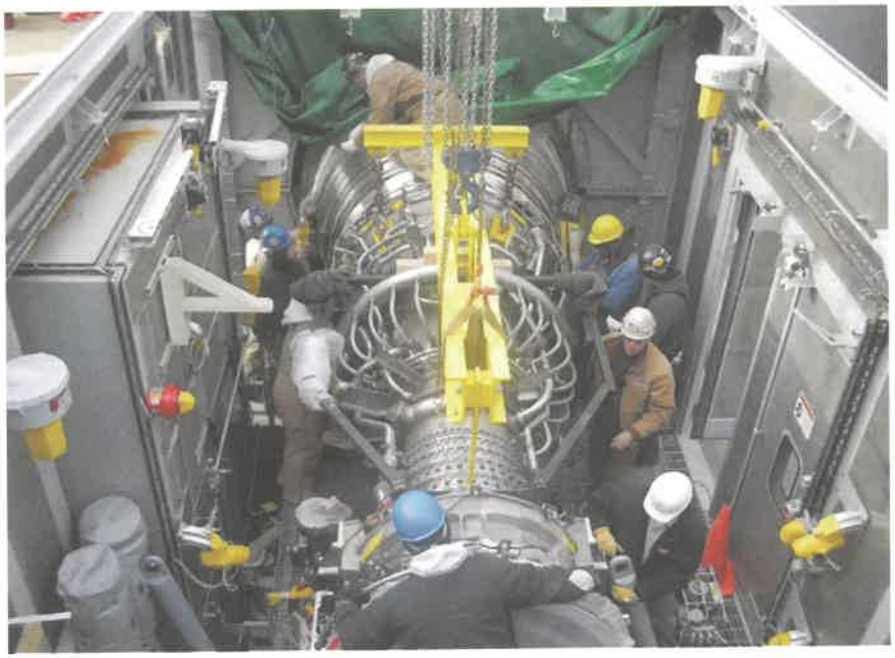


FIGURE 12
Workers wearing protective hard hats

Not all safety hard hats offer the same protective features. Although all hard hats are strong and capable of offering vital protection for a worker's head, several different types and classes of safety hard hats are available. The type and class selected depends on the type of work being performed and the hazards present in the work environment. Workers typically use one of two basic types of safety hard hat. Type 1 hard hats are intended to reduce the force of an impact on the top of the head. Type 2 hard hats are intended to reduce the force of an impact on the top and sides of the head. Hard hats can have either a small brim in the front, as shown in Figure 13, or a full brim around the hard hat to offer greater protection from heat and rain as well as shoulder and back protection. A full brim hard hat is shown in Figure 14.

FIGURE 13
Small brim hard hat

FIGURE 14
Full brim hard hat

The American National Standards Institute (ANSI) classifies safety hard hats according to the work environment for which they are best suited. To ensure they are properly protected, workers should select the correct classification of hard hat. The classifications are as follows:

- Class G (general) hard hats protect against impact, penetration, and low-voltage electrical conductors. These safety hard hats are proof-tested at 2,200 volts of electrical charge.
- Class E (electrical) hard hats protect against impact, penetration, and high-voltage electrical conductors. These safety hard hats are proof-tested at 20,000 volts.
- Class C (conductive) hard hats protect against impact and penetration only. These safety hard hats are typically made of aluminum, an electrical conductor, which makes them unsuitable for use in work involving electrical hazards.

SELF CHECK

1. List four safe work practices that a construction worker working at heights should follow.
2. List four precautions that a construction worker should take to avoid injury when working in areas vulnerable to falling tools, materials, and other objects.
3. What is the most effective way to prevent dropped-object accidents and injuries?
4. What is Foreign Material Exclusion (FME)?
5. List and describe two types and three classes of safety hard hats.

3 Safe Tool Tethering

Nearly all construction work requires the use of tools, and occasionally these tools may slip from a worker's grasp. When this occurs or some other accident causes a tool to fall from heights, the results can be both destructive and deadly. Since they are often heavy, metallic, and sharp-edged, falling tools may pierce through nets, canopies, or other protective structures. For all of these reasons, it is essential to make sure any tools used at heights are tethered to the worker or structure so that they cannot fall far enough to cause damage or injury. Tool tethers are small lanyards designed to tether the tool to either the worker or the structure.

Safe tool tethering is a common safe practice that ensures the tool will not injure persons or damage machinery or equipment below. A tool is considered to be properly tethered when it has been securely attached to the worker, such as attaching one end of a lanyard to a hammer and the other end of the lanyard to the worker's tool belt. Any tool over 5 pounds should be securely tethered to the surrounding structure, such as scaffolding.

SAFETY TIP

Always inspect the lanyard labels and check weight allowances to ensure the lanyard will not be overloaded.

SAFETY TIP

Always inspect each component of the tool anchoring system for indications of excessive wear or corrosion to ensure the system is safe to use.

SAFETY TIP

Anchor all tools weighing more than 5 pounds to a structure, not a person. Anchoring heavy tools to a person could cause injury to the person should a drop occur.

Tool Anchoring Systems

When working at heights, it is important that tools and equipment are secured so that they do not fall and injure anyone or damage equipment below. One of the most important pieces of safety equipment used for this purpose is the tool anchoring system. The tool anchoring system includes a **tool lanyard**, which is a flexible length of standard rope, wire rope, or strap with a connector at each end. One end of the tool lanyard is connected to a **tool anchorage point**, which is a secure point of attachment such as a person or fixed structure. The other end of the lanyard is fastened to a **tool tethering point**, a manufactured location on a tool used for fastening a lanyard. Figure 15 shows a tool anchoring system.

FIGURE 15

Tool anchoring system

TRADE TIP

When choosing the proper tool anchoring system, determine how far you need to be able to reach with the tool to perform the work, determine the fall clearance, and then choose the shortest lanyard possible to do the job.

Tool Lanyards

The most important component of a tool anchoring system is the lanyard. A tool lanyard is designed specifically to keep a tool secure so that if a worker drops the tool or if the tool slips over the edge of an elevated work surface, it will never reach the ground or a lower level where it may injure someone or damage structures and equipment. Tool lanyards have been designed to meet the tethering requirements of almost any tool or work situation that will be encountered. The choice of lanyard will depend on the worker, the type of work being done, the tool being used, and the load requirements.

Lanyards are available in a range of lengths, and some are elastic so they can be used in a variety of situations. Before selecting a length, the clearance required between the worker and the tool anchorage point, as well as the distance to the nearest object or person below, must be determined. The length of the worker's reach and the amount of required slack are also important factors. When working in a confined space or other areas where lanyards may snag or become tangled, a short or retractable tool lanyard would likely be the best choice. A variety of lanyards are described in this section.

TRADE TIP

Large tool lanyards capable of securing heavier tools will be labeled with "not for human use" to ensure they are not mistaken for fall arrest lanyards.

Elastic/Bungee Ideal for most applications, elastic, or bungee-style, lanyards are highly durable and are able to withstand heavy, continuous use. See Figure 16. The elasticity of these lanyards reduces snags, tangles, and trips and reduces the impact force of dropped objects. Elastic or bungee-style lanyards are a good choice for workers who need to extend their arms while working.

FIGURE 16
Elastic or bungee-style lanyard

Wire Wire lanyards are versatile, reliable, and extremely durable lanyards that can withstand harsh outdoor conditions. Due to their resistance to heat, cold, water, abrasion, and sharp edges, these heavy-duty tool lanyards are preferred by pile drivers and those who work in similarly exposed environments. An example of a wire lanyard is shown in Figure 17.

FIGURE 17
Wire lanyard with protective coating

SAFETY TIP

It is always best practice to select the shortest lanyard for the task at hand, as this will reduce the load force generated in the event of a drop.

FIGURE 18
Retractable lanyard attached to a drill

Retractable Some lanyards can be retracted into a protective block or wheel, a feature that helps reduce snags and lanyard wear. Retractable lanyards can be used with most tools and in a wide variety of situations. Some workers find a retractable lanyard, shown in Figure 18, to be a convenient choice, especially when working with drills and other heavy tools. Before these lanyards are used, workers should check the manufacturer's specifications for load rating. The mechanism is designed to retract the lanyard, not the tool; this must be kept in mind at all times.

Synthetic Synthetic lanyards are lightweight and strong, and offer a relatively inexpensive alternative to elastic, wire, or retractable lanyards. However, these lanyards are less resistant to heat, chemicals, and UV exposure. Synthetic lanyards are shown in Figure 19.

FIGURE 19
Synthetic lanyards

Creating Secure Tool Anchorage Points

Selecting the correct tool anchorage point can be critical. If any tool anchorage point is not secure, the system may fail and the tethered tool may fall, resulting in damage or injuries below. The wrist may serve as a tool anchorage point, using a Velcro® strap with a ring or similar device as shown in Figure 20, but only if the tool weighs 5 pounds or less. A sturdy tool belt worn around the worker's waist

FIGURE 20
Wrist anchorage point

FIGURE 21
Tool belt anchorage

FIGURE 22
Drill anchored to a structure

can be used as a tool anchorage point, as shown in Figure 21. When working with heavy tools such as grinders, circular saws, or large drills the tool anchorage point should be on a piece of heavy equipment, building, or other structure. See Figure 22.

Tethering and Retrofitting Tools

Today, manufacturers are addressing the problem of dropped objects by designing tools to allow for tethering. However, almost all construction tools not designed with tethering points can be retrofit with tethering points. **Retrofit** is the installation of a tethering point on a tool that was manufactured without one. Figure 23 shows an example of a tool that has been retrofit with a tethering point and a tool that was manufactured with a tethering point.

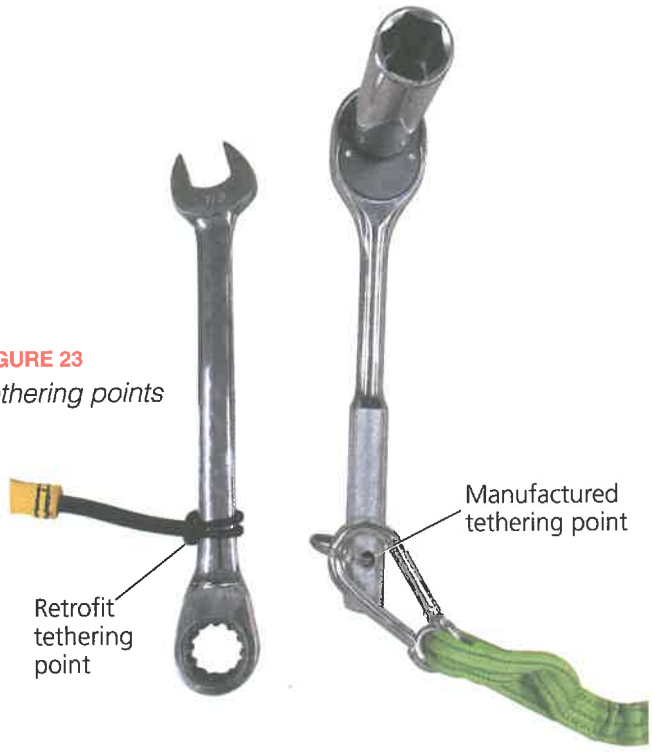


FIGURE 23
Tethering points

Like other safety devices, tool tethering is only effective if it is properly used. Improper selection and use may give workers a false sense of security. Several considerations that can help workers make safe use of tool tethering and prevent accidents and injuries from dropped tools are listed in this section.

Ensure Proper Training Workers must be properly trained before using tools at heights or attaching them to tethers. They must be taught how to properly attach tethering point to tools, how to use lanyards properly, and how to determine the proper load rating of lanyards. Since training cannot cover every situation, workers should consult with their foreman when in doubt.

Pass Tools With Care The use of care and common sense when passing tools to other workers can prevent a tool from being dropped. Even so, some tools will be dropped while being passed. For this reason, the worker receiving a passed tool must connect it to an anchor before it is passed. This will ensure the tool is tied off throughout the exchange and will not become a dropped-object hazard.

Consider Tool Weight Heavy tools require sturdier lanyards and more secure tool anchorage points, such as a building or other fixed structure. Tools that weigh more than 5 pounds should never be anchored to a person, as this may lead to falls or injuries and may not prevent the tool from falling. If a heavy tool were dropped while anchored to a worker, the weight and force could dislocate a wrist or shoulder or even pull a worker over a ledge or off a scaffold platform.

Use Energy-Absorbing Lanyards All lanyards should be made of materials that absorb energy and slow the descent of a dropped tool instead of stopping it with a sudden jerk. This will prevent injuries by helping workers maintain their balance if a tool is dropped.

Use Retractable Tool Lanyards Snagging or tangling a lanyard can be dangerous and may lead to a fall or dropped-object incident. To avoid this, it may be best to use a retractable tool lanyard or quick release tether.

Anchor Hoisted Tools Hoisted tools should be anchored before they are passed to the worker who will use them. This can prevent tools from becoming dropped-object hazards before workers receive and properly anchor them. Only tools that will be needed for construction tasks and processes should be hoisted.

Tool Tethering Points It is common for workers to use specific points on a tool as tethering points or to retrofit a tethering point. Depending on the tool and the design, the locations of these points will vary. The tethering point might be a hole that was manufactured into the tool's design, or it may

SAFETY TIP

When choosing a tool lanyard, ensure that it does not limit the use of the tool. If the tool is obstructed, it may be difficult to use and may make it tempting to leave the tool unsecured.

TRADE TIP

When tools need to be passed off to other workers, carabiners are a good connector option to quickly and easily make the pass.

SAFETY TIP

When passing a tool to another worker, it should be done while standing in a safe zone, if possible, and not while standing outside a scaffold or over open equipment.

TRADE TIP

Tool lanyards should not be modified in any way because this may change the load rating and make the lanyard unsuitable for use with heavier tools.

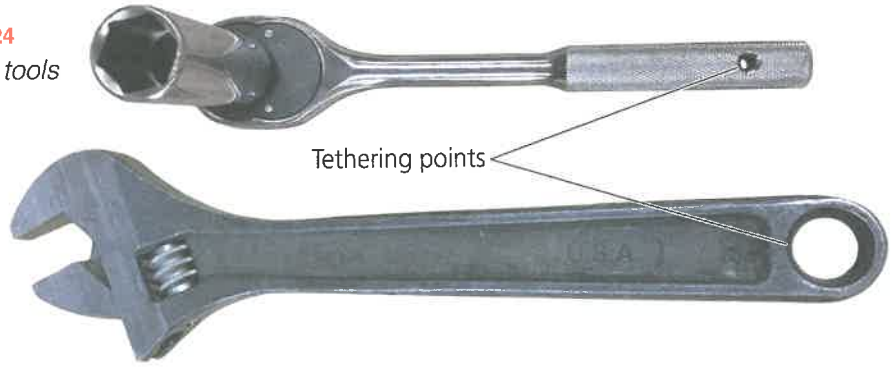
TRADE TIP

To prevent being pulled into machinery, never use tool tethers in situations that could entangle them in moving parts of a machine.

be the body of the tool itself. The following types of tools are commonly tethered or retrofit with tethering points.

- captive tools: have a fully enclosed hole or handle built into the body of the tool; see Figure 24
  - adjustable wrenches, hand saws, or pipe wrenches

FIGURE 24
Captive tools



- open-ended tools: have handles that have no tethering points; see Figure 25
  - hammers and ratchet wrenches
- insulated tools: constructed of nonconductive materials and are suitable for doing electrical work; see Figure 26
  - pliers with insulated grips
- molded-handle tools: plastic grips are attached to the tool; see Figure 27
  - small long-nose pliers or linemen's pliers

FIGURE 25
Open-ended tools

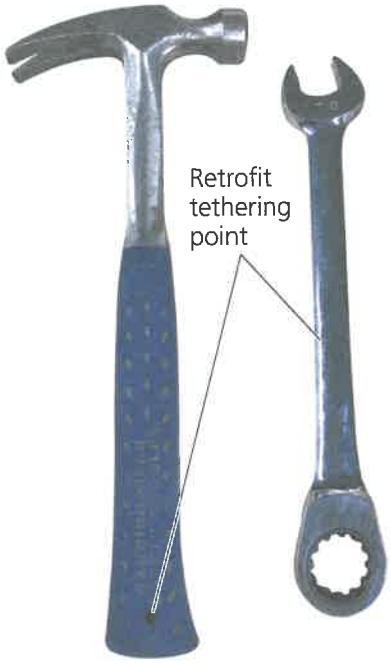


FIGURE 26
Insulated tools

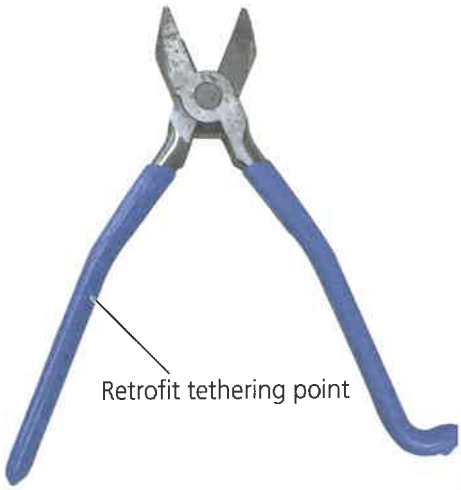
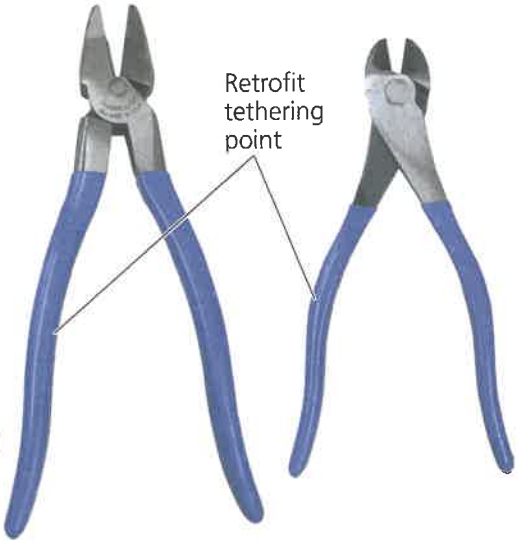


FIGURE 27
Molded-handle tool

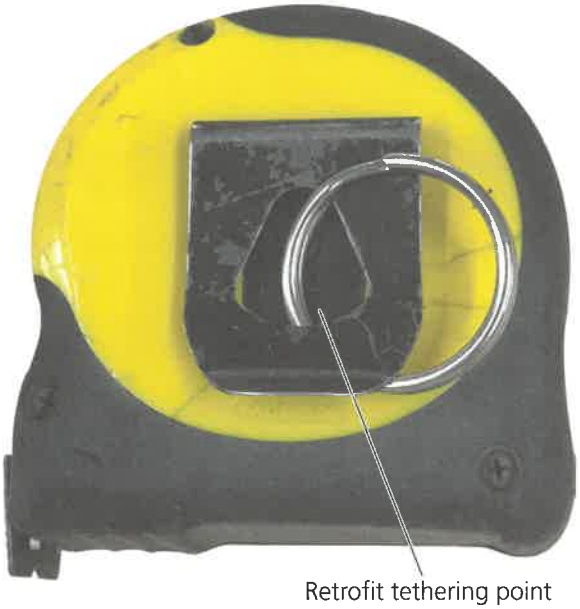


- rotating tools: require rotary action to perform their function; see Figure 28
  - screwdrivers
- power tools: require a power source such as an electrical cord or removable battery; see Figure 29
  - drills, impact drivers, or grinders
- miscellaneous tools or equipment: do not fit into the previous categories; see Figure 30
  - PPE, clamps, tape measure, water bottles, and so on

FIGURE 28
Rotating tool

FIGURE 29
Power tool

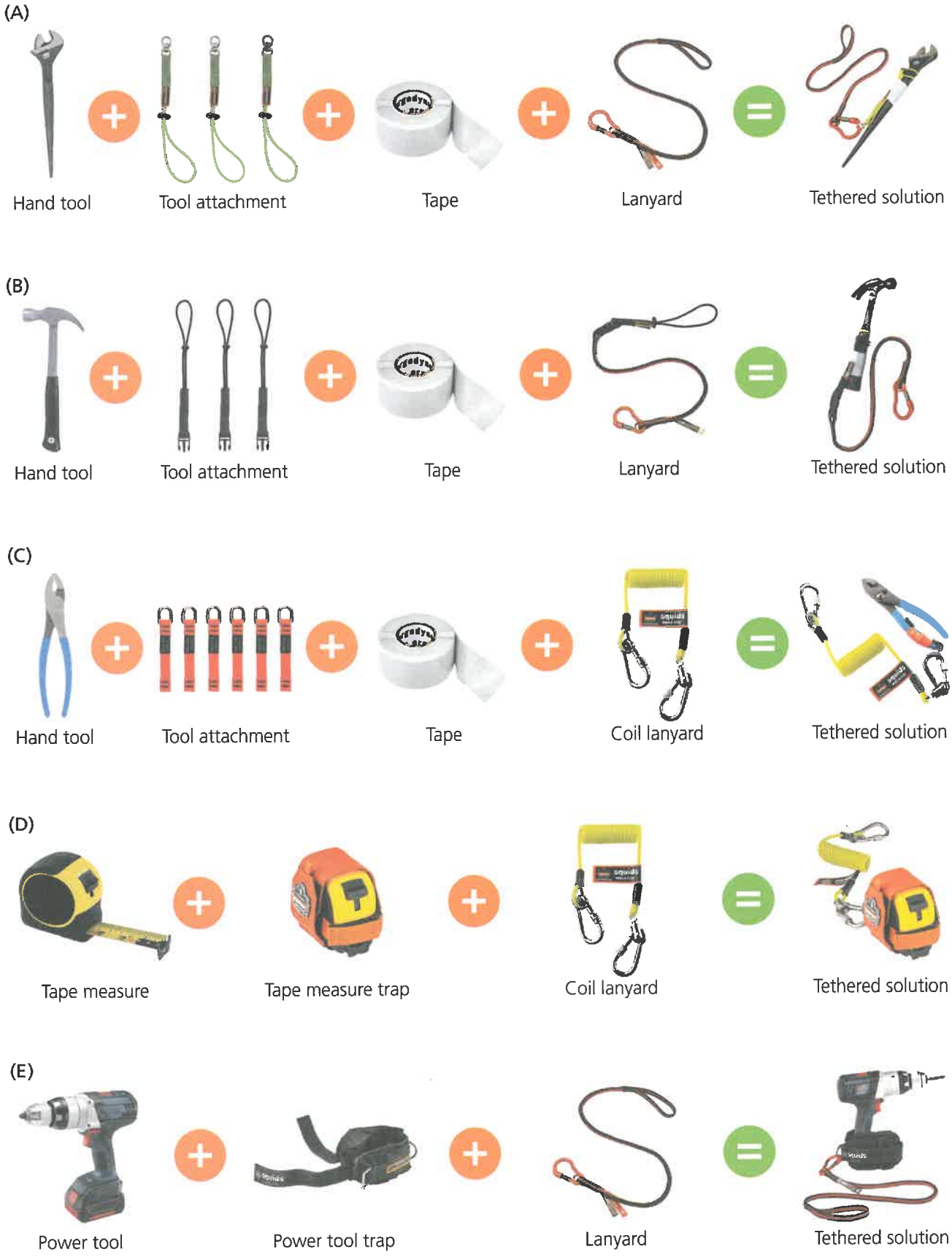
FIGURE 30
Miscellaneous tool



Retrofitting Although an increasing number of tools have manufactured tethering points, many do not. To make sure a tool can be securely anchored, it may be necessary to retrofit the tool. This can be done in a variety of ways, including using shrink-wrap, rings, cinches, sleeves, and other types of tool attachments. Tethering tape is

often used, either alone or in conjunction with other tool attachments such as a strap fitted with a D-ring or loop. Figure 31 shows a variety of methods in which hand tools, power tools, and even measuring tapes can be retrofitted. Various tool attachments are described as follows:

FIGURE 31
Examples of retrofitting tools



- Shrink-wrap is typically used with a loop or cinch-type tether strap to create a retrofit tether point on tools such as hammers. Cold shrink technology requires no heat source for the shrink-wrap to work. Figure 32 shows a tethering point that has been fastened to tools with shrink-wrap.
- Rings are typically used with tools that have handles with holes. Although this design was originally intended to hang the tool, it makes a good tethering point for a ring, as shown in Figure 33.
- Cinches can be tethered to the tapered midsection of shaped tools. See Figure 34.
- Tether tape in conjunction with a D-ring can be used to retrofit tools. Tether tape is a self-adhering, rubber-based product that adheres to itself and leaves no residue. No heat source is needed for tether tape to adhere; it is activated by stretching it as it is wrapped around a tool. The tape is strong and can be installed quickly. A tool that has been retrofit with a D-ring and tether tape is shown in Figure 35.
- Sleeved tool tethers are formed by holding the tool in place with one hand while the sleeve is slipped over the handle with the other. The tethering point rotates to create a tangle-resistant attachment. Figure 36 shows a quick spin sleeved tethering point.

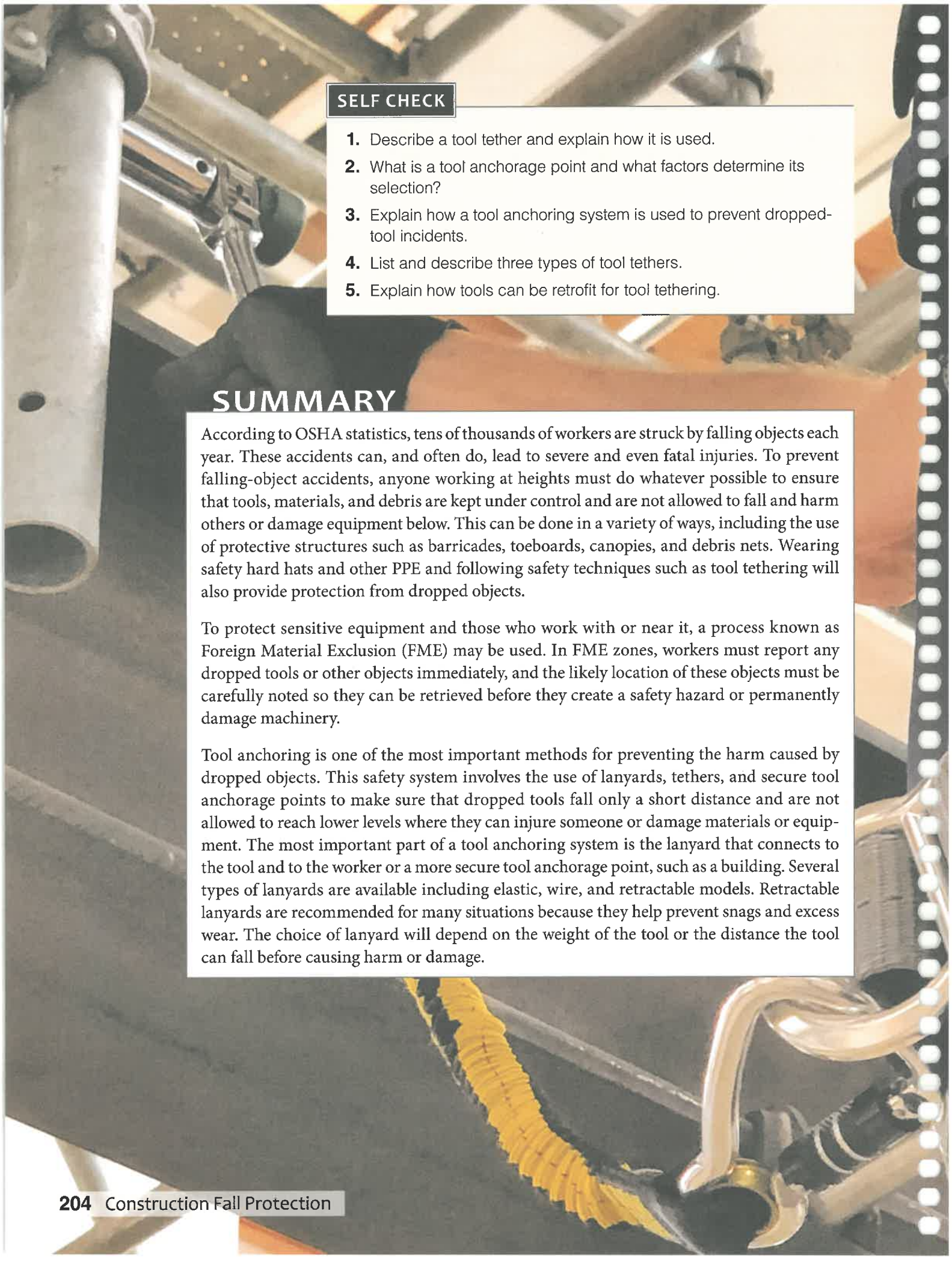
FIGURE 32
Tools retrofit with shrink-wrap

FIGURE 33
Tin snips retrofit with ring

FIGURE 34
Tool retrofit with cinch

FIGURE 35
Tool retrofit with tether tape

FIGURE 36
Tools retrofit with sleeve



SELF CHECK

1. Describe a tool tether and explain how it is used.
2. What is a tool anchorage point and what factors determine its selection?
3. Explain how a tool anchoring system is used to prevent dropped-tool incidents.
4. List and describe three types of tool tethers.
5. Explain how tools can be retrofit for tool tethering.

SUMMARY

According to OSHA statistics, tens of thousands of workers are struck by falling objects each year. These accidents can, and often do, lead to severe and even fatal injuries. To prevent falling-object accidents, anyone working at heights must do whatever possible to ensure that tools, materials, and debris are kept under control and are not allowed to fall and harm others or damage equipment below. This can be done in a variety of ways, including the use of protective structures such as barricades, toeboards, canopies, and debris nets. Wearing safety hard hats and other PPE and following safety techniques such as tool tethering will also provide protection from dropped objects.

To protect sensitive equipment and those who work with or near it, a process known as Foreign Material Exclusion (FME) may be used. In FME zones, workers must report any dropped tools or other objects immediately, and the likely location of these objects must be carefully noted so they can be retrieved before they create a safety hazard or permanently damage machinery.

Tool anchoring is one of the most important methods for preventing the harm caused by dropped objects. This safety system involves the use of lanyards, tethers, and secure tool anchorage points to make sure that dropped tools fall only a short distance and are not allowed to reach lower levels where they can injure someone or damage materials or equipment. The most important part of a tool anchoring system is the lanyard that connects to the tool and to the worker or a more secure tool anchorage point, such as a building. Several types of lanyards are available including elastic, wire, and retractable models. Retractable lanyards are recommended for many situations because they help prevent snags and excess wear. The choice of lanyard will depend on the weight of the tool or the distance the tool can fall before causing harm or damage.

Dropped-Object Hazard Control

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. A ____ is a component used to link two parts of a tool anchoring system.
   a. rod
   b. chain
   c. connector
   d. linkage line

2. The most efficient and effective method of controlling fall hazards and dealing with the threat of dropped objects is _____.

3. Workers can make their most important contribution to their own safety and the safety of others by following _____ _____ _____.

4. Workers are just as likely to be threatened by falling objects as they are to cause an accident by dropping a tool or other object themselves. (True; False)

5. The use of _____ or _____ for tools and objects that are being used on an elevated work level is an effective method of preventing dropped-object accidents.

6. When properly placed along the perimeter of scaffold platforms and other elevated work surfaces, ____ can prevent countless accidents by making sure tools, materials, and other objects do not slide or roll over the edge.
   a. guardrails
   b. canopies
   c. debris nets
   d. toeboards

7. ____ help prevent dropped-object accidents by offering a protective, reinforced roof-like covering for sidewalks and other pedestrian passageways.
   a. Guardrails
   b. Canopies
   c. Debris nets
   d. Toeboards

8. ____ is a set of standardized procedures used to make sure stray tools and debris are kept out of machinery and sensitive areas.
   a. STOL
   b. RTD
   c. FME
   d. CFEC

9. A ____ safety hard hat protects against impact, penetration, and high-voltage electrical conductors and is proof-tested at 20,000 volts.
   a. Class G
   b. Class E
   c. Class C
   d. Class D

10. A ____ safety hard hat protects against impact and penetration but is unsuitable for use in work involving electrical hazards.
   a. Class G
   b. Class E
   c. Class C
   d. Class D

11. A(n) _____ is a secure point of attachment, such as a person or fixed structure.

12. Only tools weighing no more than ____ should be attached to a worker's wrist or tool belt.
   a. 3 pounds
   b. 5 pounds
   c. 7 pounds
   d. 10 pounds

13. ____ can be done using special devices such as a sleeved tool tether that uses the tool's handle as an anchor point.
   a. Removing anchor points
   b. Retrieving tools
   c. Restoring tools
   d. Retrofitting tools

14. The choice of lanyard depends on the worker, the type of work being done, the tool being used, and the _____ requirements.

15. A(n) ____ lanyard features a protective block or wheel designed to help reduce snags and lanyard wear.
   a. wire
   b. retractable
   c. elastic
   d. bungee

16. A(n) ____ lanyard is resistant to heat, cold, water, abrasion, and sharp edges, and is often preferred by pile drivers and those who work in similarly exposed environments.
   a. wire
   b. retractable
   c. elastic
   d. bungee

17. When working with heavy tools such as grinders, circular saws, or large drills, the tool anchorage point should be a piece of heavy equipment, a building, or other structure. (True; False)

18. A ____ is a manufactured or retrofit connector used for fastening a lanyard.
- **a.** bungee
- **b.** tool tether
- **c.** bracket
- **d.** tool anchorage point

19. When a tool is dropped, the worker who dropped it may be in danger as well as those below. (True; False)

20. Tools can also be retrofit using _____ _____, a self-adhering, rubber-based product which adheres to itself and leaves no residue.

WORKSHEET 1

Dropped Objects

Instructions To prevent damage to equipment and injury to workers, it is important to have preventive measures in place that will help ensure that tools are not dropped when working at heights. Read the scenario below and come up with some suggestions as to the measures that could have been taken to prevent this from occurring. Write your suggestions on the lines provided.

Scenario

Tom has reported an incident in which a falling object hit and destroyed someone's hard hat. Two pile drivers, Jason and Dale, were in the process of setting the upper section of a lattice boom crane. Having set the section in place, Dale left the immediate area and boarded the MEWP so that he could access the top section of the crane in order to release the rigging used to set the lattice boom. Jason, the other worker and who was approximately 30 feet below, continued to secure the bolt pins of the upper section to the already established lower section.

As Dale was maneuvering the basket of the MEWP his safety lanyard got caught on the sledge hammer tether that was attached to his tool belt and flipped the 5-lb. sledgehammer sideways, causing it to fall out of the basket. The hammer fell and struck Jason's hard hat, causing it to shatter and resulting in head injuries to Jason.

WORKSHEET 2

Tools and Tethering Methods

Instructions In the spaces provided below, using tools supplied by the instructor, list the proper tethering methods for each.

1. _____

2. _____

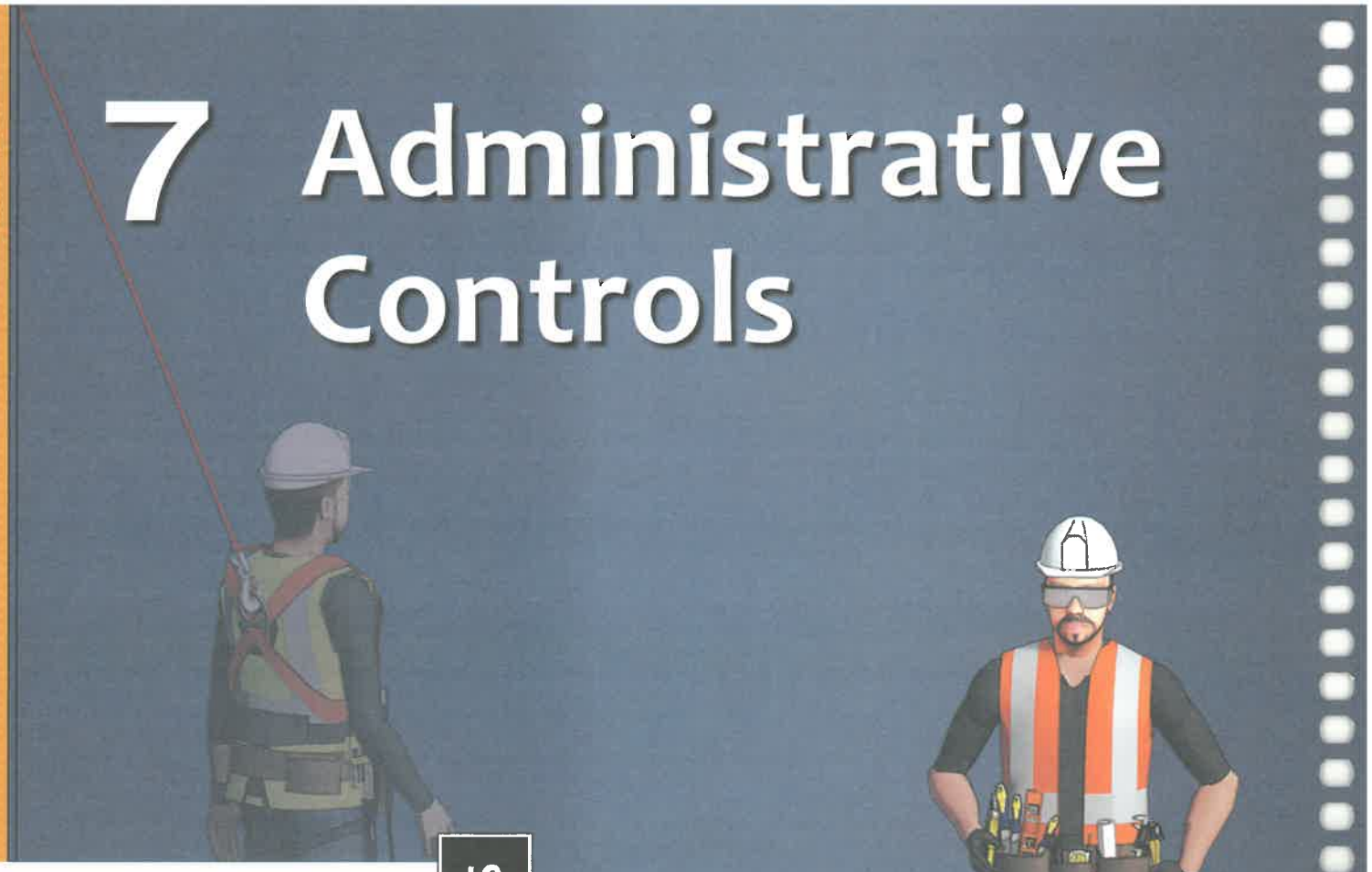
3. _____

4. _____

5. _____

CHAPTER

7 Administrative Controls



INTRODUCTION

Administrative controls are work practices or procedures that are put in place to help workers avoid hazards and accidents. Instead of removing physical fall hazards or providing workers with fall protection equipment, administrative controls are intended to change workers' behavior and steer them away from hazardous locations and activities.

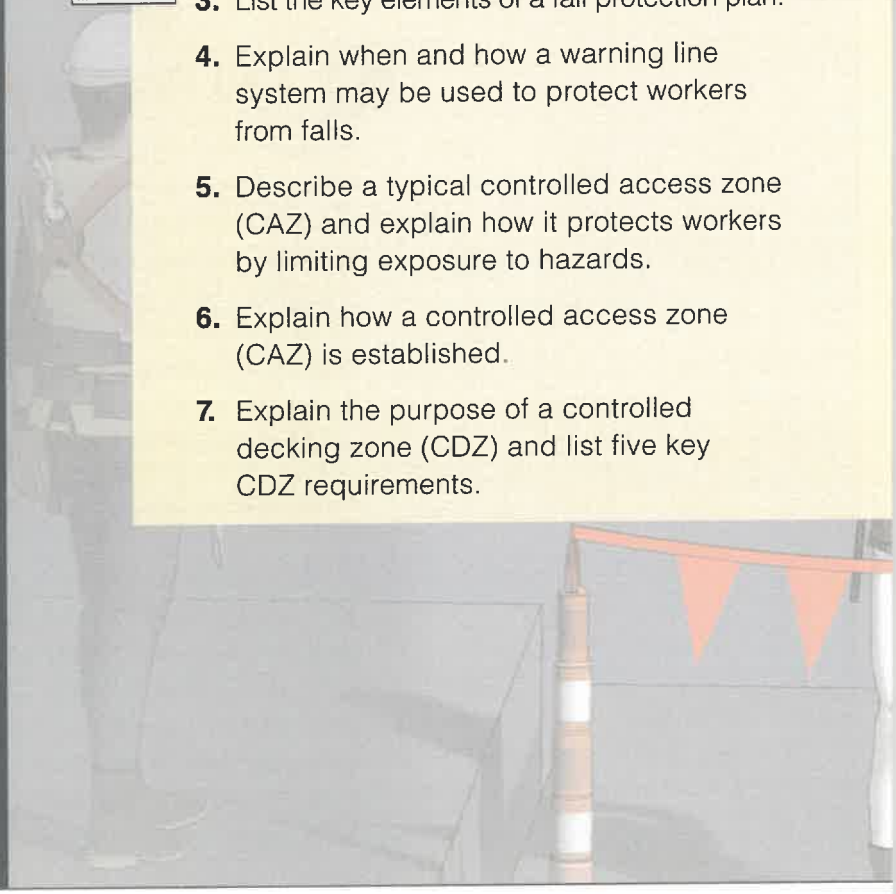
This chapter describes each of these common types of administrative control, and explains how they are implemented and the role they play in a fall protection plan.

CONTENTS

OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. Explain how administrative controls are different from other types of fall prevention and protection.
2. Explain when and how administrative controls are commonly used.
3. List the key elements of a fall protection plan.
4. Explain when and how a warning line system may be used to protect workers from falls.
5. Describe a typical controlled access zone (CAZ) and explain how it protects workers by limiting exposure to hazards.
6. Explain how a controlled access zone (CAZ) is established.
7. Explain the purpose of a controlled decking zone (CDZ) and list five key CDZ requirements.



KEY TERMS

Key Terms are in order of appearance.

administrative controls work practices or procedures intended to help workers avoid hazards, accidents, and injuries

controlled access zone (CAZ) designated and clearly marked work area where certain types of work may take place without the use of conventional fall protection systems

warning line system barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge

safety monitoring system administrative control used as a fall protection system in which a safety monitor has the sole duty of using voice commands to protect workers doing leading edge work from fall hazards

safety monitor competent person who is given responsibility for recognizing and identifying construction site fall hazards and warning workers to avoid them

fall protection plan list of fall protection systems required at a specific construction site, including a description of where and when each must be used

qualified person individual who, by possession of recognized degrees, certificates, or professional standing; or by extensive knowledge, training, and experience; has demonstrated the ability to resolve safety issues or solve other work-related problems

Continued on next page

KEY TERMS (continued)

competent person individual capable of identifying existing or potential hazards in working conditions or surroundings and who has been given authority to take prompt corrective measures

control line barrier, typically made of rope or wire, that designates the controlled access zone

controlled decking zone (**CDZ**) area in which initial installation or placement of metal decking may take place without the use of guardrail systems, personal fall arrest systems, fall restraint systems, or safety net systems and where access to the zone is controlled

1 Fall Protection Plans

Safety is always the most important consideration at a jobsite, and contractors, supervisors, and workers must put safety first in every circumstance. One way of doing this is through the use of **administrative controls**, which are work practices or procedures intended to help workers avoid hazards, accidents, and injuries. Instead of eliminating or minimizing physical fall hazards or providing workers with safety equipment, administrative controls work by changing the behavior of workers and steering them away from hazardous locations and activities. This can be accomplished with the use of controlled access zones, warning line systems, or safety monitoring systems.

Controlled access zones (**CAZs**) are designated and clearly marked work areas where certain types of work may take place without the use of conventional fall protection systems. **Warning line systems** are barriers erected on a roof to warn employees that they are approaching an unprotected roof side or edge. A **safety monitoring system** is an administrative control used as a fall protection system in which a safety monitor has the sole duty of using voice commands to protect workers doing leading edge work from fall hazards. A **safety monitor** is a competent person who is given responsibility for recognizing and identifying construction site fall hazards and warning workers to avoid them. Most situations require that the administrative controls used to protect workers from falls and fall-related injuries must be carefully planned and implemented well before workers are exposed to fall hazards on the construction site. Figure 1 shows one type of administrative control.

It is difficult, if not impossible, to build a structure without a plan, and the same might be said about maintaining a safe work environment. A well-organized plan plays an important part in keeping workers safe and preventing falls and fall-related injuries. When conventional fall protection techniques such as guardrails, safety nets, and personal fall arrest systems are either insufficient or are not feasible, employers are required by OSHA and OH&S to develop a written fall protection plan. A **fall protection plan** is a list of the fall protection systems required at a specific construction site, including a description of where and when each system must be used.

A fall protection plan is required for any construction site with fall hazards exceeding 6′-0″ and where such hazards lack guardrails or similar means

FIGURE 1
Warning line system

of protecting workers. This plan must be in writing and must be posted or otherwise made accessible to workers. The plan must also be completed and made available at the construction site before any work that might place workers in danger of falling is done.

Fall Protection Plan Preparation

A fall protection plan must be prepared by a qualified person. A **qualified person** is an individual who, by possession of recognized degrees, certificates, or professional standing; or by extensive knowledge, training, and experience; has demonstrated the ability to resolve safety issues or solve other work-related problems. In this case, the qualified person must be extensively knowledgeable concerning fall protection systems. Since jobsite circumstances are constantly changing, the measures taken to protect workers from falls may need to be changed as well. This requires that fall protection plans be revised and updated on a regular basis.

Fall Protection Plan Implementation

The person who implements a fall protection plan is not necessarily the same person who prepared it in the first place or who approved changes in the plan. The plan must be implemented under the supervision of a competent person. A **competent person** is an individual capable of identifying existing or potential hazards in working conditions or surroundings and who has been given authority to take prompt corrective measures. The employer is responsible for designating the competent person. The fall protection responsibilities of the competent person include the following:

- implements and supervises the fall protection plan
- selects the best fall protection equipment for specific applications
- ensures proper installation of safety equipment
- inspects safety equipment
- ensures that workers are properly trained to use the safety equipment selected

Elements of a Fall Protection Plan

A fall protection plan is prepared for a specific jobsite and will list all known fall hazards, either existing or potential, anywhere at the site. The plan will specify the fall protection systems that must be used to protect workers from these hazards, along with the procedures required to assemble, maintain, inspect, use, or disassemble these systems. The plan must also include the following essential elements:

- anchorages to be used for various tasks and types of fall protection equipment
- confirmed clearance distances below various work areas
- procedures required for rescuing fallen workers

If conventional fall protection methods will not work or would endanger workers, the fall protection plan must contain an explanation as to why this is the case and the explanations must be carefully documented. The plan must include alternative fall protection methods and practices and explain how they will be implemented. Each location where conventional fall protection will not be used must be identified as a controlled access zone (CAZ). A controlled access zone is a designated and clearly marked work area where certain types of work may take place without the use of conventional fall protection systems. A controlled access zone is shown in Figure 2. Controlled access zones are described in greater detail later in this chapter.

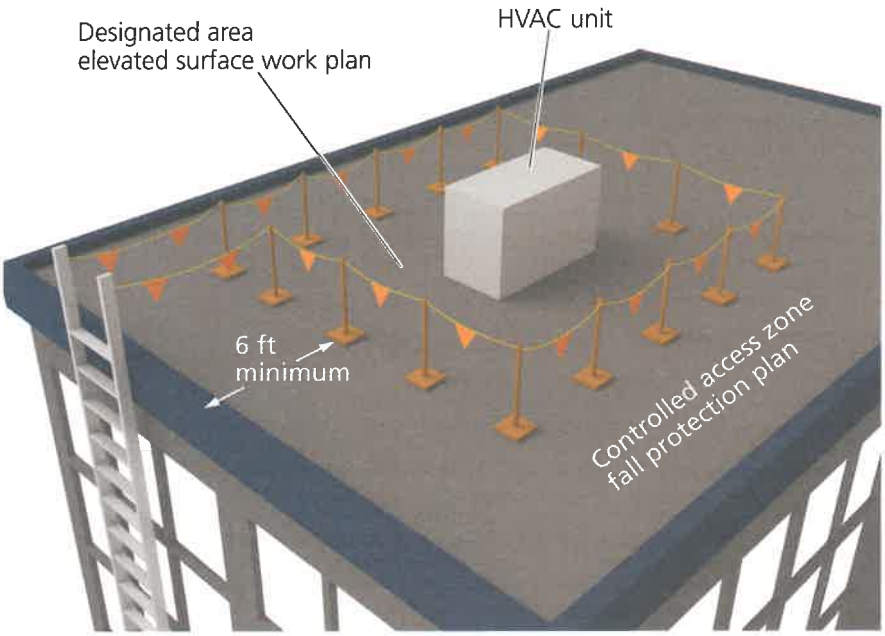


FIGURE 2
Controlled access zone

TRADE TIP

Safety monitoring systems may not be permitted, depending on your location. Always check local, state, provincial, and federal regulations; the most stringent regulations shall be followed.

Safety Monitoring System

OSHA regulatory publications refer to a safety monitoring system as an administrative control used as an alternative fall protection option for roofing work. A safety monitoring system employs the use of a safety monitor, a competent person whose sole responsibility is to protect personnel by recognizing and identifying construction site fall hazards and warning

workers to avoid them through the use of voice commands. If contractors elect to use a safety monitoring system, they must designate a competent person to monitor the safety of workers and to warn them when a task or process puts them too close to a fall hazard.

To perform the safety monitoring function effectively, a competent person must be experienced and highly skilled in the identification of fall hazards. It is best practice that the monitor not be required to oversee more than eight workers at one time. The designated safety monitor must have no other active duties that may distract from the task at hand. The monitor must remain on the same walking or working surfaces as the workers and must be close enough to see the workers clearly and speak to them directly. The monitor must warn workers whenever they appear to be unaware of fall hazards or whenever they may be acting in an unsafe manner. Figure 3 shows a competent person serving as a safety monitor.

FIGURE 3
Safety monitor

Safety monitoring systems must be used as part of a fall protection plan when no alternative measure has been implemented. They should be used only when no other means of fall protection is feasible. Circumstances calling for the use of safety monitoring should be clearly defined in the contractor's overall safety plan. OSHA states that other safety monitoring system requirements include the following:

- Mechanical equipment must not be used or stored in areas where safety monitoring systems are being used to monitor workers engaged in roofing operations.
- No worker, other than one engaged in roofing work or one covered by a fall protection plan, may enter an area where a worker is being protected by a safety monitoring system.
- All workers in a CAZ must be instructed to promptly comply with fall hazard warnings issued by safety monitors.

United States Army Corps of Engineers (USACE) Requirements

The United States Army Corps of Engineers (USACE) sets and enforces its own rules, regulations, and standards, and those related to safety and fall protection are especially strict. Any contractor engaged in a USACE project with personnel working at heights or exposed to fall hazards must submit a Fall Protection and Prevention Plan to the proper Government Designated Authority (GDA) for review and approval. This plan will be part of a comprehensive Accident Prevention Plan (APP). These plans may be developed by either a competent person or qualified person.

More detailed than a typical construction site fall protection plan, a USACE Fall Protection and Prevention Plan must include the name of the competent or qualified person who prepared it, along with their qualifications and responsibilities. It must detail the specific practices, equipment, and control methods that will be used to protect workers. The plan must be updated at least once every six months or whenever conditions at the construction site change.

Fall Protection Requirements in Canada

In Canada, a separate fall protection plan is not always required for each construction site. Contractors dealing with the same fall hazards at multiple sites and using the same fall protection equipment and rescue procedures for each may rely on a single plan. A separate or amended plan would be required only if circumstances at one of the sites change. Canadian safety agencies require proper fall protection training for any worker likely to be exposed to fall hazards. Workers who will be exposed to fall hazards must have access to the fall protection plan and must receive proper training in each relevant element of the plan.

SELF CHECK

1. Explain what a fall protection plan is and list the elements it must include.
2. Why is it necessary to revise fall protection plans on a regular basis?
3. What are the responsibilities of the competent person put in charge of preparing a fall protection plan?
4. Describe a typical safety monitoring system.
5. What are the requirements of a USACE Fall Protection and Prevention Plan and who reviews the plan to make sure the requirements are met?

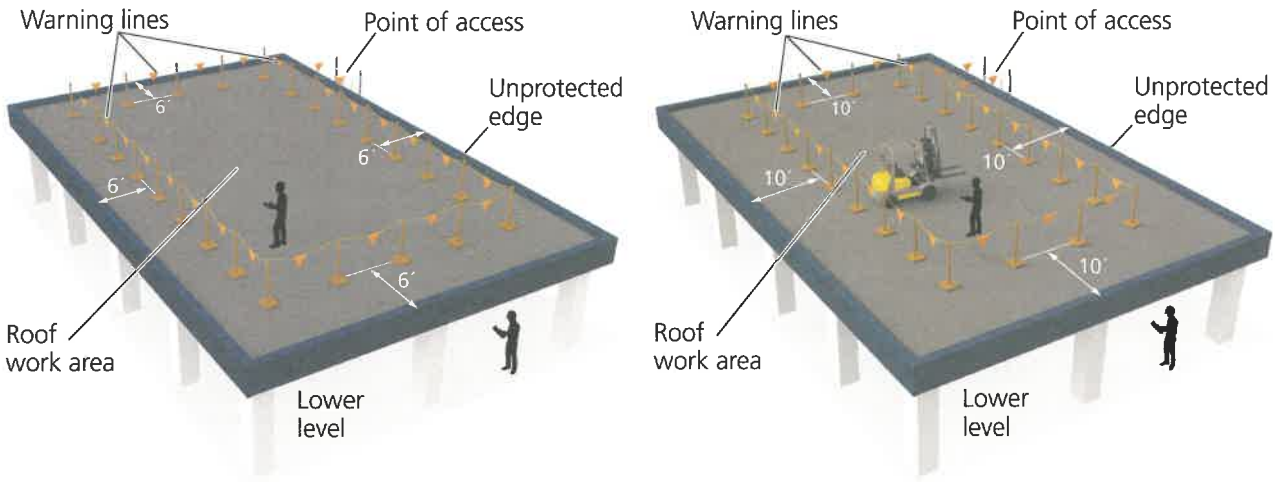
2 Warning Line Systems

A warning line system is a barrier erected on a roof or other elevated surface to warn workers that they are approaching an unprotected side or edge. The system designates an area where roofing or other work can be done without the use of guardrails, body harnesses, or safety net systems to protect workers. An example of a warning line system is shown in Figure 4.

Warning Line Placement

Warning line systems typically consist of ropes, wires, or chains and supporting stanchions. According to OSHA, this system should be erected around all sides of the roof work area at least 6′-0″ from the edge of the roof. In Canada, this measurement is 6′-6″. If mechanical equipment will be used, the warning line must run parallel to the direction of equipment operation and no less than 10′-0″ from the roof edge, which is perpendicular to

FIGURE 4
Warning line system



Warning line system where no mobile equipment is used

Warning line system where mobile equipment is used

FIGURE 5
Warning line placement

the direction of equipment operation. Figure 5 shows proper warning line placement for roofing jobs.

Access Points

Points of access, material-handling areas, storage areas, and hoisting areas must be connected to the work area by an access path formed by two warning lines. When these secondary or special-purpose areas are not in use and the access path is not needed, it should be blocked off by an additional warning line or gate to prevent workers from walking directly into the work area, as shown in Figure 6. Personnel not involved in performing the required work in the designated work area must remain outside of the area.

Warning Line Requirements

OSHA regulations state that all warning lines must be flagged with high-visibility material at no more than 6′-0″ intervals. They must be rigged and supported so the lowest point, including sag, is no less than 34″ from the

FIGURE 6
Warning line access path

walking or working surface and the highest point is no more than 39″ from the walking or working surface.

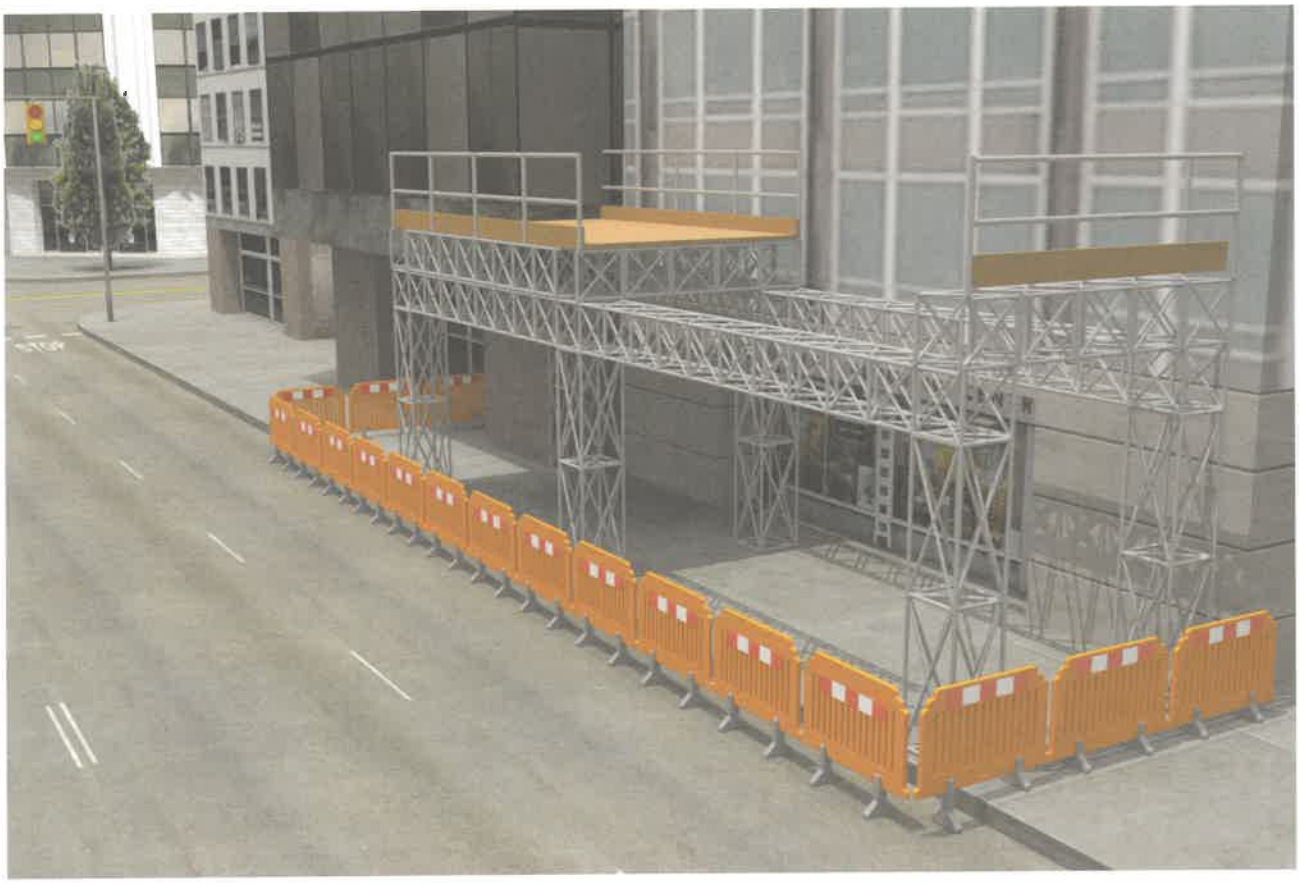
Warning line stanchions must remain stable. After being rigged with warning lines the stanchions must be capable of resisting a blow from the side without tipping over. Stanchions should be able to remain upright when struck with a force of up to 16 pounds applied horizontally against the stanchion at a point 30″ above the walking or working surface.

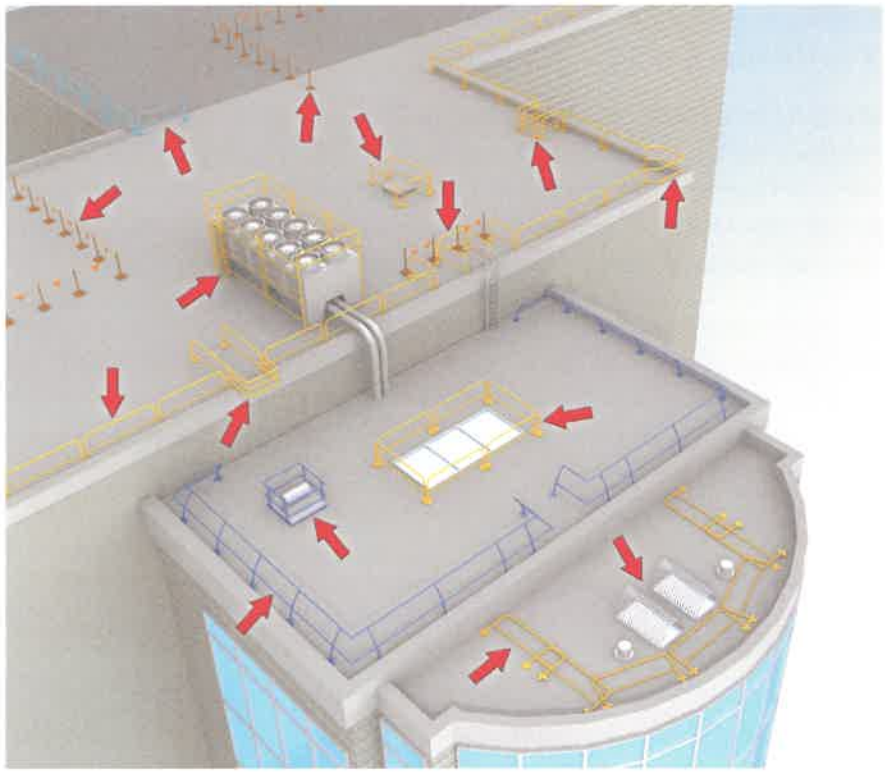
Materials used for ropes or other warning line rigging must have a minimum tensile strength of 500 pounds, and once attached to the stanchions must be capable of supporting the load applied to the stanchions without breaking. Warning lines must be attached to each stanchion in such a way that pulling on one section of the warning line between stanchions will not result in slack being taken up in adjacent sections.

3 Controlled Access Zones (CAZs)

Another type of administrative control often used to protect workers from falls or falling objects is a controlled access zone (CAZ). Controlled access zones, such as the one shown in Figure 7, reduce the number of workers exposed to fall hazards from unprotected sides and edges by limiting access to the hazardous area. Only authorized personnel are allowed in a CAZ

FIGURE 7
Controlled access zone





and each of them should have CAZ training. CAZs are commonly used by contractors engaged in residential construction, precast concrete erection, overhand bricklaying, and leading edge work. In most cases, CAZs are used only when other, more conventional fall protection systems are considered impractical or infeasible.

A CAZ is established by a competent person who will define the controlled area. This is typically done using a **control line**, a barrier consisting of ropes, wires, tapes, or equivalent materials and that is clearly marked with signs. OSHA regulations state that CAZ control lines should be flagged or marked at least every 6′-0″ so they can be clearly seen. To enhance visibility, the line is supported so that its lowest point, including sag, is not less than 39″ from the walking and working surface, and its highest point is not more than 45″ from the walking and working surface. Each line must have a minimum breaking strength of 200 pounds and must extend the entire length of the leading or unprotected edge. Each control line must be anchored at both ends to a guardrail system or wall.

Although they may be similar in appearance, warning lines and control lines are used in different circumstances and in different ways. Warning lines are used in low-slope or flat roofing work as a barrier to keep workers inside a safe work area. CAZ control lines are used most often in leading edge work, overhand bricklaying, and the erection of precast concrete members to establish a barrier and keep workers out unless they are performing necessary tasks. For example, a CAZ established in an area where overhand bricklaying was taking place would be intended to keep out everyone except workers engaged in the bricklaying.

CAZ Control Line Requirements

In order to effectively control access and protect workers, control lines must meet certain requirements, and these can differ depending on the circumstances and the type of work being performed. In most cases, control lines must be established at least 6′-0″ and no more than 25′-0″ from the unprotected or leading edge. Control lines must extend along the entire length of the unprotected side or leading edge and run parallel to it. The lines must also be connected on each side to a guardrail system or wall.

CAZs for Precast Concrete Erection It is often necessary to establish CAZs when erecting precast concrete members. The control line requirements are very similar to those applying to other types of work. However, the maximum control line distance from the leading or unprotected edge is 60′-0″ instead of 25′-0″, or half the length of the member, whichever is less. This means if the precast member is 30′-0″ long, the maximum distance is 15′-0″ from the leading edge.

CAZs for Overhand Bricklaying Areas where workers are engaged in overhand bricklaying should be guarded by CAZs. The OSHA and OH&S requirements for CAZs are as follows:

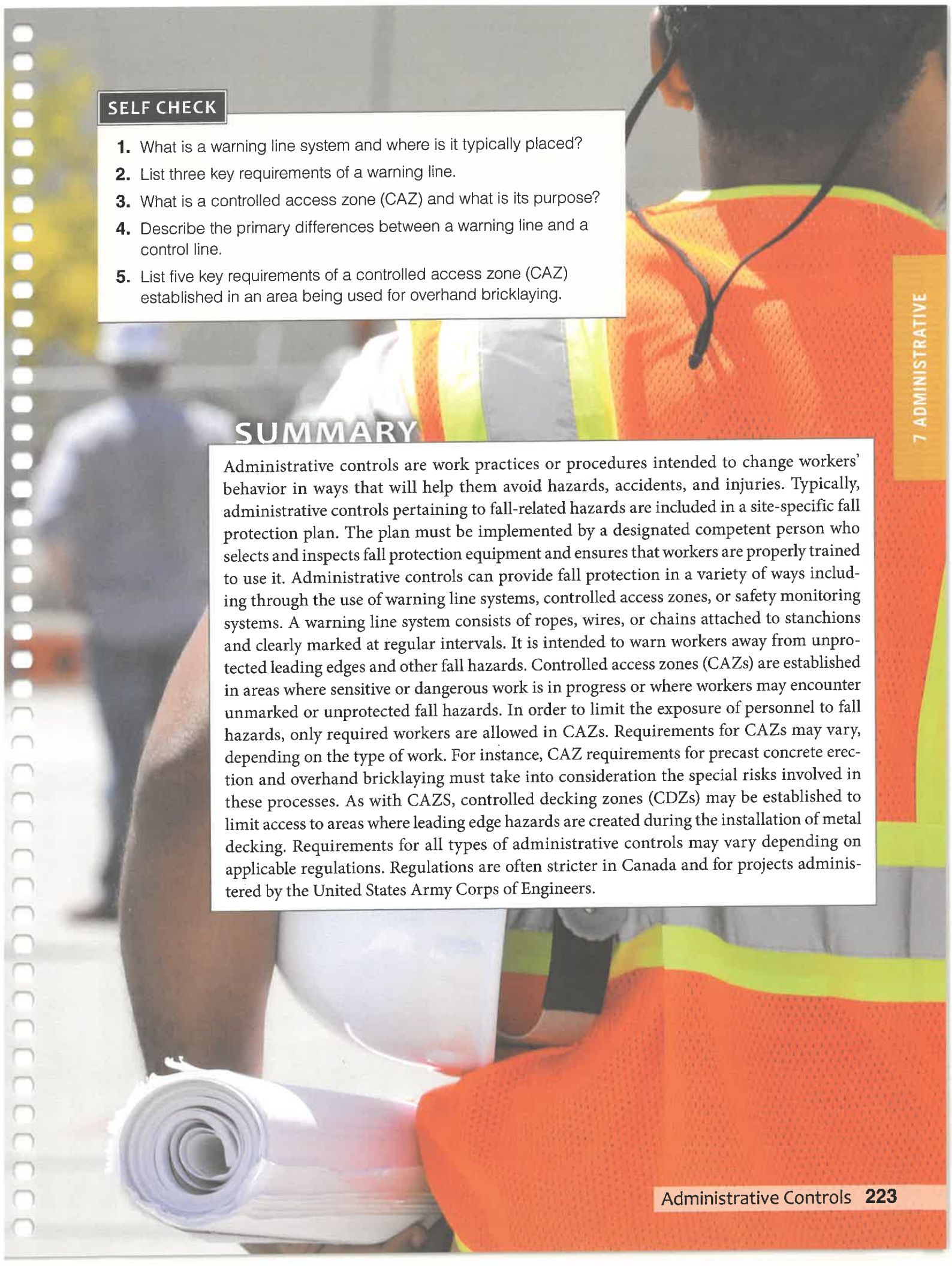
- Control lines consisting of ropes, wires, tapes, or equivalent materials and supporting stanchions must be erected at least 10′-0″ and no more than 15′-0″ from the edge of the work area.
- Control lines must be approximately parallel to the edge of the work area and must extend far enough to enclose all workers performing overhand bricklaying and related work.
- Additional control lines must be erected at each end of the CAZ to enclose the work area.
- Control lines must be flagged or otherwise clearly marked at not more than 6′-0″ intervals with high-visibility material. In Canada they must be flagged at 6′-6″ intervals.
- Only workers engaged in overhand bricklaying or related work are permitted in the controlled access zone.
- Control lines must be rigged and supported in such a way that the lowest point, including sag, is not less than 39″ from the walking or working surface and the highest point is not more than 50″ from the walking or working surface when overhand bricklaying operations are underway.
- Control lines must have a breaking strength of at least 200 pounds.
- On floors and roofs where guardrail systems are not in place prior to the beginning of overhand bricklaying operations, CAZs must be enlarged as necessary to enclose all points of access, material handling areas, and storage areas.
- Existing floor and roof guardrail systems must be left in place, except for portions that must be removed to allow overhand bricklaying or leading-edge operations. If any sections are removed, they must be replaced once the day's work is complete.

Controlled Decking Zone (CDZ)/Metal Decking

When work is being done in a decked area near a leading edge, it may be necessary to establish a controlled decking zone (CDZ) such as the one shown in Figure 8. A **controlled decking zone (CDZ)** is an area in which initial installation or placement of metal decking may take place without the use of guardrail systems, personal fall arrest systems, fall restraint systems, or safety net systems and where access to the zone is controlled. A controlled decking zone may be required when metal decking is being installed and forms a leading edge 15′-0″ above a lower level. The following OSHA and OH&S regulations apply to CDZs:

- Workers near a leading edge in a CDZ must be protected from fall hazards of more than two stories or 30′-0″, whichever is less.
- Access to a CDZ must be limited to workers engaged in leading edge work.
- Designated boundaries of a CDZ must be clearly marked by control lines.
- The CDZ must not be more than 90′-0″ wide and 90′-0″ deep from any leading edge.
- All personnel working in a CDZ shall have completed CDZ training.
- Unsecured decking in a CDZ shall not exceed 3,000 sq. ft.
- Safety deck panels must be attached in the CDZ from the leading edge back to the control line and must have at least two attachments for each metal panel.
- Final deck attachments and installation of shear connectors must be performed in the CDZ.

FIGURE 8
Controlled decking zone (CDZ)



SELF CHECK

1. What is a warning line system and where is it typically placed?
2. List three key requirements of a warning line.
3. What is a controlled access zone (CAZ) and what is its purpose?
4. Describe the primary differences between a warning line and a control line.
5. List five key requirements of a controlled access zone (CAZ) established in an area being used for overhand bricklaying.

SUMMARY

Administrative controls are work practices or procedures intended to change workers' behavior in ways that will help them avoid hazards, accidents, and injuries. Typically, administrative controls pertaining to fall-related hazards are included in a site-specific fall protection plan. The plan must be implemented by a designated competent person who selects and inspects fall protection equipment and ensures that workers are properly trained to use it. Administrative controls can provide fall protection in a variety of ways including through the use of warning line systems, controlled access zones, or safety monitoring systems. A warning line system consists of ropes, wires, or chains attached to stanchions and clearly marked at regular intervals. It is intended to warn workers away from unprotected leading edges and other fall hazards. Controlled access zones (CAZs) are established in areas where sensitive or dangerous work is in progress or where workers may encounter unmarked or unprotected fall hazards. In order to limit the exposure of personnel to fall hazards, only required workers are allowed in CAZs. Requirements for CAZs may vary, depending on the type of work. For instance, CAZ requirements for precast concrete erection and overhand bricklaying must take into consideration the special risks involved in these processes. As with CAZS, controlled decking zones (CDZs) may be established to limit access to areas where leading edge hazards are created during the installation of metal decking. Requirements for all types of administrative controls may vary depending on applicable regulations. Regulations are often stricter in Canada and for projects administered by the United States Army Corps of Engineers.

Administrative Controls

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. If a fall protection plan is required, it must be completed and made available at the construction site before any work that may place workers in danger of falling is done. (True; False)

2. A fall protection plan is required for any construction site with unprotected fall hazards exceeding a height of _____.
   a. 5′-0″
   b. 6′-0″
   c. 7′-0″
   d. 8′-0″

3. If conventional fall protection methods will not work or would endanger workers, the fall protection plan must explain why this is the case, and these explanations must be carefully documented. (True; False)

4. A(n) _____ is a designated and clearly marked work area where certain types of work may take place without the use of conventional fall protection systems.
   a. CAZ
   b. PPE
   c. JHA
   d. FME

5. No worker other than one covered by a fall protection plan or engaged in roofing work may enter an area where a worker is being protected by a safety monitoring system. (True; False)

6. A warning line system is a(n) _____ erected on a roof to warn workers that they are approaching an unprotected roof side or edge.

7. All warning lines must be rigged and supported so the lowest point, including sag, is no less than 34″ from the walking or working surface and the highest point is no more than _____ from the walking or working surface.
   a. 39″
   b. 40″
   c. 42″
   d. 45″

8. Stanchions should be able to remain upright when struck with a force of up to 16 pounds applied horizontally against the stanchion at _____ above the walking or working surface.
   a. 18″
   b. 24″
   c. 30″
   d. 36″

9. Material serving as a warning line must have a minimum tensile strength of ____.
   a. 150 pounds
   b. 250 pounds
   c. 400 pounds
   d. 500 pounds

10. A controlled access zone (CAZ) reduces the number of workers exposed to fall hazards from unprotected sides and edges by _____ _____ to the hazardous area.

11. The materials used to establish the lines of a controlled access zone (CAZ) must have a minimum breaking strength of ____.
   a. 100 pounds
   b. 200 pounds
   c. 300 pounds
   d. 500 pounds

12. When erecting precast concrete members, the maximum controlled access zone (CAZ) control line distance from the leading or unprotected edge is ____.
   a. 15′-0″
   b. 30′-0″
   c. 60′-0″
   d. 75′-0″

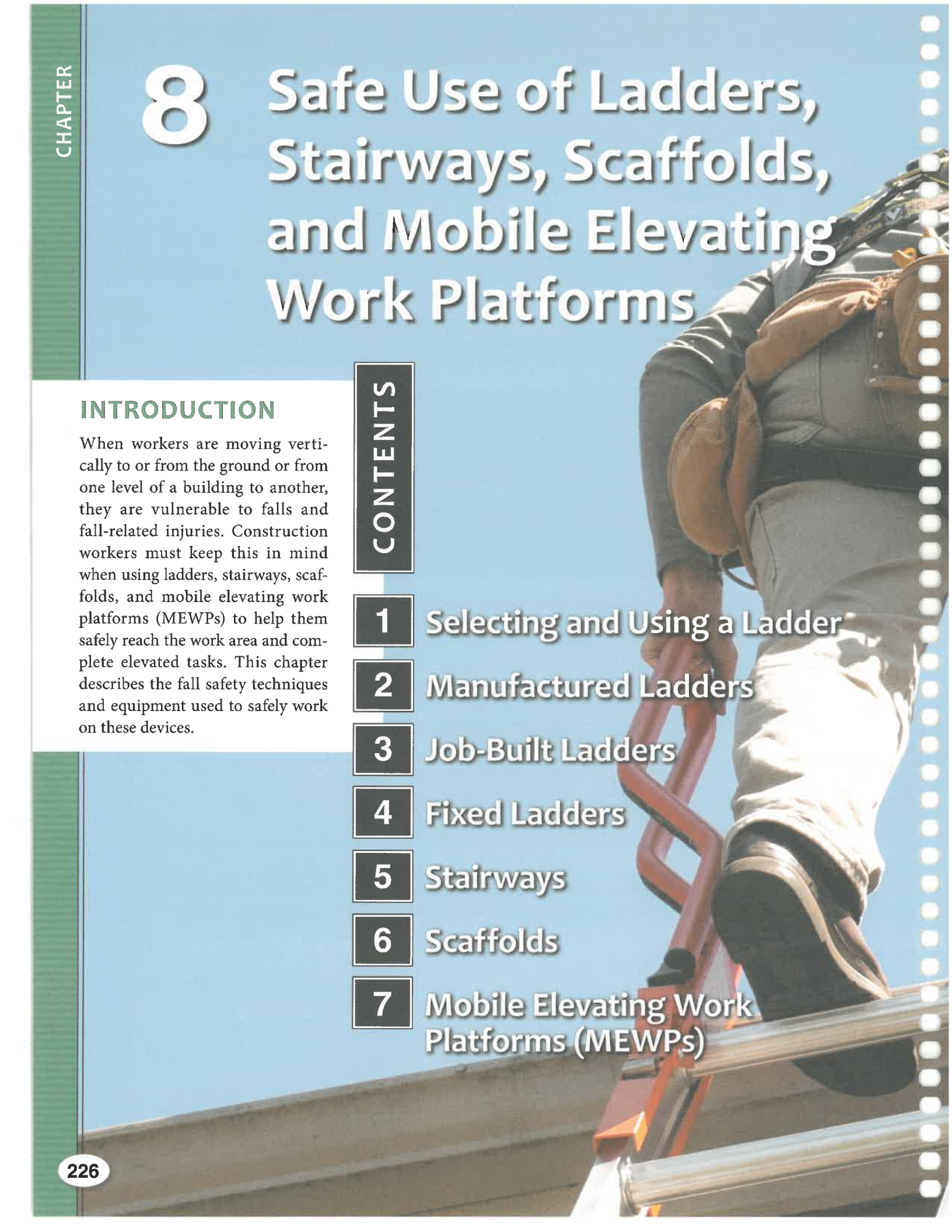
13. On floors and roofs where guardrail systems are not in place prior to the beginning of overhand bricklaying operations, controlled access zones (CAZs) must be enlarged as necessary to enclose all _____ _____ _____, material handling areas, and storage areas.

14. Controlled decking zones (CDZs) must not be more than ____ from any leading edge.
   a. 45′-0″
   b. 60′-0″
   c. 75′-0″
   d. 90′-0″

15. Since jobsite circumstances are constantly changing, the measures taken to protect workers must remain fixed so workers can rely upon them. (True; False)

CHAPTER 8

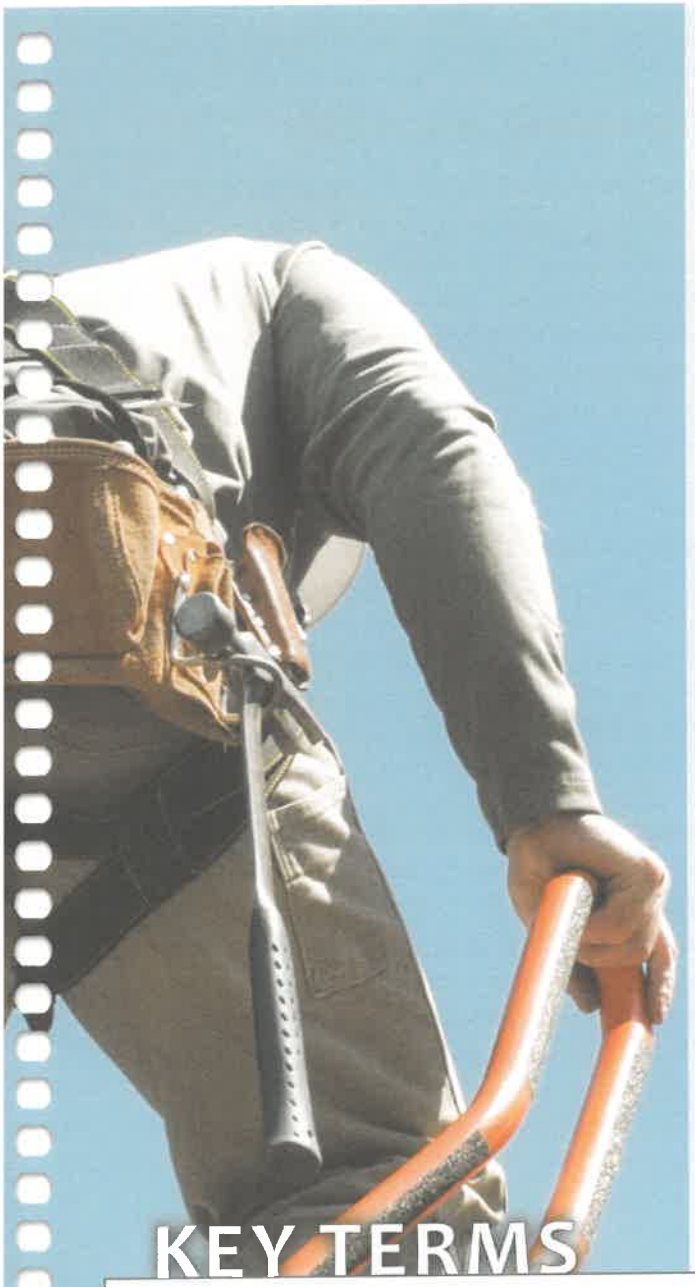
Safe Use of Ladders, Stairways, Scaffolds, and Mobile Elevating Work Platforms



INTRODUCTION

When workers are moving vertically to or from the ground or from one level of a building to another, they are vulnerable to falls and fall-related injuries. Construction workers must keep this in mind when using ladders, stairways, scaffolds, and mobile elevating work platforms (MEWPs) to help them safely reach the work area and complete elevated tasks. This chapter describes the fall safety techniques and equipment used to safely work on these devices.

CONTENTS



OBJECTIVES

Upon successful completion of this chapter, the participant should be able to:

1. List three considerations when selecting the proper ladder for the task.
2. Explain what to look for when inspecting a ladder.
3. Describe how to properly set up a straight ladder.
4. Demonstrate how to properly set up and adjust an extension ladder.
5. Describe safety rules that must be followed when using ladders.
6. List and describe the safety requirements for temporary stairs and job-built stair systems.
7. Explain how handrails, guardrails, and stair rails are installed and used to protect workers from falls.
8. Explain the appropriate fall protection systems required for a specific scaffold application.
9. List and describe the fall protection requirements for three different types of mobile elevating work platforms (MEWPs).
10. Explain the appropriate fall protection systems required for a MEWP application.

KEY TERMS

Key Terms are in order of appearance.

stepladder self-supporting portable ladder with flat steps and a hinged base and that cannot be adjusted for length

platform ladder self-supporting portable ladder with a hinged base that has a stable standing area

straight ladder or **single ladder** non-self-supporting, portable ladder that cannot be adjusted for length

extension ladder non-self-supporting portable ladder that can be adjusted for length

job-built ladder temporary wooden ladder custom made for specific construction tasks

fixed ladder vertical ladder consisting of steps or rungs mounted permanently to a structure

duty rating maximum allowable load a device can safely support

cage enclosure fastened to the side rails of a fixed ladder or to the structure to encircle the climbing space of the ladder and help prevent falls

handrail stair system component designed to be grasped by a hand to provide stability and support

stair rail barrier erected along the exposed or open side of stairways to prevent employees from falling to a lower level

scaffold temporary elevated or suspended work platform for workers, tools, and materials

mobile elevating work platform (**MEWP**) mechanical device used to provide temporary access for people or equipment to elevated work areas

1 Selecting and Using a Ladder

Found on almost every construction site, ladders offer a relatively convenient and low-cost means of reaching higher levels or work areas and are used for a wide range of industrial applications. Ladders are so common that some workers may take them for granted, which can be a serious mistake. A ladder is a tool like any other and must be treated with respect and used with care. When used improperly, ladders are dangerous and may represent a fall hazard. In regards to safety, a contractor's goal should be to strive for zero incidents and zero injuries to help ensure that each worker returns home from the jobsite uninjured each day.

Project sites are inherently dangerous areas, and the use of ladders contributes to this danger. Ladders are convenient and can be easily moved from one work location to another, which can result in improper and unsafe use. For example, workers may not take the time to properly set up and secure the ladder before climbing it, which can result in falls and possible injuries. Workers who become complacent while working on the jobsite are more likely to be injured.

Many contractors have begun to implement a program known as "Ladders Last," which states that ladder use is allowed only when all other options to complete a task are not feasible. See Figure 1. The program is based on prevention rather than protection. This program requires pre-task planning and writing site-specific safety plans on how to complete a task without using a ladder. "Ladders Last" challenges traditional ideals and helps inspire newer, safer ways of performing work. Identifying other means of access or elevated work platforms that better protect workers and promote safe work habits can help to reduce the number of potential incidents on the jobsite.

Ladder Safety

To prevent falls and other incidents and the severe injuries they may cause, workers must be properly trained in the safe use of ladders and

FIGURE 1
"Ladders Last"

must carefully follow all OSHA, OH&S, and other applicable safety rules and regulations. According to the Bureau of Labor Statistics, 50 percent of all ladder-related accidents were due to individuals carrying items as they climbed. According to a study by the American Ladder Institute, the top five causes of accidents are missing the last step of the ladder when descending, overreaching while on the ladder; using the wrong size ladder; not placing the ladder on firm, level ground; and not using three points of contact while climbing the ladder.

Most ladder safety rules are based on proven, commonsense procedures related to ladder selection, inspection, setup, use, storage, and maintenance. Positioning, securing, ascending, and descending ladders must be done in the safest manner possible. The three-point contact rule should always be followed. This means that at any time while climbing a ladder, both feet and one hand or both hands and one foot must be on the ladder. When these guidelines are carefully followed, most ladder-related accidents and injuries can be avoided.

Choosing Ladders

The first rule of ladder safety is the selection of the right ladder for the required task. This is not always a simple matter, since ladders are made from various materials and are available in a wide variety of types, sizes,

SAFETY TIP

Use tool lanyards when working on ladders to prevent tools from being dropped on workers below.

FIGURE 2
Ladder Safety: Choosing the Right Ladder

lengths, and duty ratings. The information needed for selection of the proper ladder is shown in Figure 2.

LADDER SAFETY

CHOOSING THE RIGHT LADDER

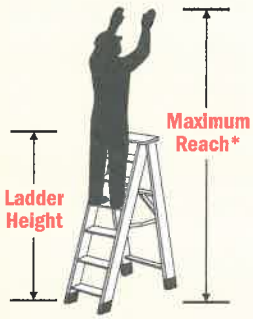
CHOOSE THE RIGHT MATERIAL

The first factor in choosing the right ladder is your work environment. If you are working near power lines, an aluminum ladder should not be used since it conducts electricity. On the other hand, if you are not doing electrical work, the aluminum ladder is the lightest weight when compared to fiberglass or wood. Wood ladder works well indoors. It offers solid functionality in affordable price.

ALUMINUM	FIBERGLASS	WOOD
Lightweight, easier to transport.	Lightweight, easier to transport.	Heavy.
Noncorrosive, suitable for indoor & outdoor use.	Noncorrosive, suitable for indoor & outdoor use.	Noncorrosive, but do not hold-up well in outdoor since it deteriorates if left unprotected from moisture.
Electrical conductive, dangerous to use around electrical wires.	Nonconductive, ideal for electrical work.	Nonconductive.
Damaged easier by rough usage.	Strong & durable.	More solid than aluminum ladder.
Cheaper than fiberglass ladders.	More expensive than aluminum & wooden ladders.	Cheaper than aluminum and fiberglass ladders.

CHOOSE THE PROPER LENGTH

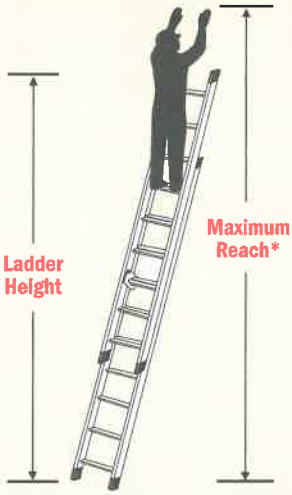
STEPLADDER



LADDER HEIGHT	MAXIMUM REACH*
3 ft. (0.9 m)	7 ft. (2.1 m)
4 ft. (1.2 m)	8 ft. (2.4 m)
5 ft. (1.5 m)	9 ft. (2.7 m)
6 ft. (1.8 m)	10 ft. (3 m)
7 ft. (2.1 m)	11 ft. (3.4 m)
8 ft. (2.4 m)	12 ft. (3.7 m)
10 ft. (3 m)	14 ft. (4.3 m)
11 ft. (3.4 m)	15 ft. (4.6 m)
12 ft. (3.7 m)	16 ft. (4.9 m)
14 ft. (4.3 m)	18 ft. (5.5 m)
16 ft. (4.9 m)	20 ft. (6.1 m)

* Assumes a 5.6 ft (1.7 m) person with a vertical 12 inch (30.5 cm) reach.

EXTENSION LADDER



LADDER HEIGHT	MAXIMUM REACH*
16 ft. (4.9 m)	15 ft. (4.6 m)
20 ft. (6.1 m)	19 ft. (5.8 m)
24 ft. (7.3 m)	23 ft. (7 m)
28 ft. (8.5 m)	27 ft. (8.2 m)
32 ft. (9.8 m)	31 ft. (9.4 m)
36 ft. (11 m)	34 ft. (10.4 m)
40 ft. (12.2 m)	37 ft. (11.3 m)

CHOOSE THE RIGHT CAPACITY

Next, consider the **Duty Rating** of the ladder.
It is an indication of the maximum weight capacity of a ladder.

Your Weight
+
The Weight of Your Clothing and Protective Equipment
+
The Weight of Tools and Supplies You Are Carrying
≤
Ladder Duty Rating

5 Categories of Ladder Duty Ratings:

Load Capacity	Application	CSA	ANSI
200 lbs./91 kg	Light Duty	Grade 3	Type III
225 lbs./102 kg	Medium Duty	Grade 2	Type II
250 lbs./113 kg	Heavy Duty	Grade 1	Type I
300 lbs./136 kg	Extra Heavy Duty	Grade 1	Type IA
375 lbs./170 kg	Extra Heavy Duty	Grade 1	Type IAA

The Duty Rating of your ladder can be found on the specifications label. Safety standards require a Duty Rating sticker to be placed on the side of every ladder. Do not assume that a longer ladder has a higher weight capacity. There is no relationship between ladder length and weight capacity.

Choosing the right ladder depends in part on a careful evaluation of the required task and work environment, and the answers to several key questions. For instance, how high is the work that must be accessed? Are there any obstructions, damp areas, electrical sources, or other hazards that must be considered? Is the work area crowded with people or materials? Will the ladder be resting on an uneven surface? Will the ladder be manufactured or job-built? Some of these factors will be discussed later in this section.

Ladder Materials

Most ladders are made from aluminum, fiberglass, wood, steel, or a combination of these materials. Common materials used to manufacture ladders are shown in Figure 3. Some materials are better suited than others for a given type of work or work environment.

- Aluminum ladders are strong and lightweight, but are not as durable as fiberglass. They also conduct electricity.
- Fiberglass ladders are most often found on construction sites because they are durable, withstand weathering, are stable, and have a high duty rating.
- Wood ladders may be preferred when working in a high-heat environment as they are not as hot to the touch as aluminum, fiberglass, or steel ladders. Wood ladders that are dry do not conduct electricity.
- Steel ladders are often found as "fixed ladders" attached to a structure on a construction site. Figure 4 shows ladders made of aluminum, fiberglass, wood, and steel.

SAFETY TIP

Never use aluminum ladders near power lines because they conduct electricity.

FIGURE 3
Choose the Right Material

CHOOSE THE RIGHT MATERIAL

The first factor in choosing the right ladder is your work environment. If you are working near power lines, an aluminum ladder should not be used since it conducts electricity. On the other hand, if you are not doing electrical work, the aluminum ladder is the lightest weight when compared to fiberglass or wood. Wood ladder works well indoors. It offers solid functionality in affordable price.

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Electrical conductive, dangerous to use around electrical wires.	Nonconductive, ideal for electrical work.	Nonconductive.
Damaged easier by rough usage.	Strong & durable.	More solid than aluminum ladder.
Cheaper than fiberglass ladders.	More expensive than aluminum & wooden ladders.	Cheaper than aluminum and fiberglass ladders.

FIGURE 4
Ladder material types

Ladder Types

Several types of ladders are commonly used by construction professionals. These include stepladders, platform ladders, straight or single ladders, extension ladders, job-built ladders, and fixed ladders. A **stepladder** is a self-supporting portable ladder with flat steps and a hinged base, and cannot be adjusted for length. Stepladders, also known as A-frame ladders, are meant to be used by a worker to access work areas while remaining on the ladder. A stepladder is shown in Figure 5. A **platform ladder** is a self-supporting portable ladder with a hinged base that has a stable standing area. These ladders are a safer alternative to stepladders because they provide a more stable and secure standing area. A platform ladder is shown in Figure 6. A **straight ladder**, or **single ladder**, is a non-self-supporting, portable ladder that cannot be adjusted for length and that consists of one section of side members and steps, or rungs. Straight ladders can be used to access work areas at lower heights. A straight ladder is shown in Figure 7. An **extension ladder** is a non-self-supporting, portable ladder that can be adjusted for length. Extension ladders are used to access work areas at greater heights. An extension ladder is shown in Figure 8. Both straight and extension ladders allow workers to exit from the ladder. A **job-built ladder** is a temporary wooden ladder that is custom made for specific construction tasks. A job-built ladder is shown in Figure 9. A **fixed ladder** is a vertical ladder consisting of steps, or rungs, mounted permanently to a structure. A fixed ladder is shown in Figure 10.

FIGURE 5
Stepladder

FIGURE 6
Platform ladder

FIGURE 7
Straight or single ladder

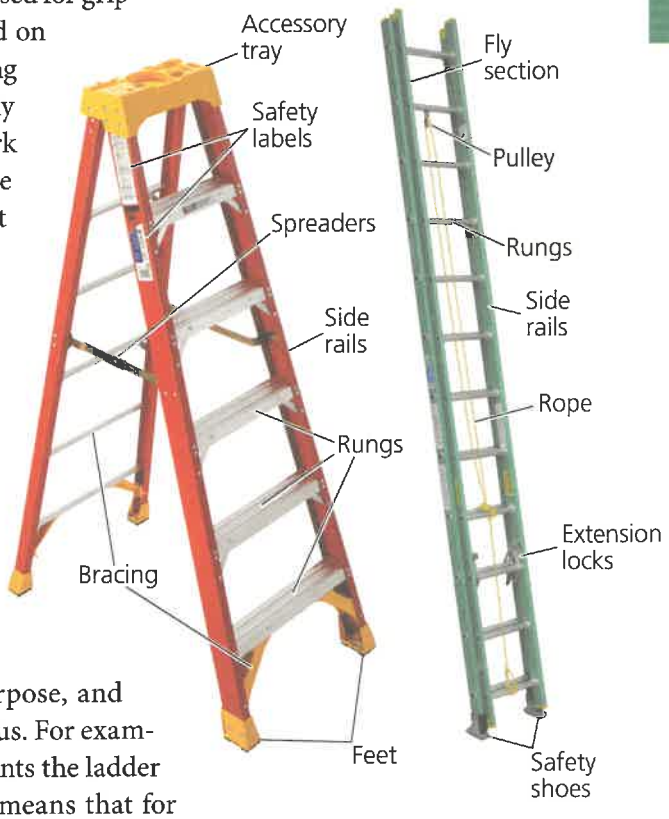
FIGURE 8
Extension ladder

FIGURE 9
Job-built ladder

FIGURE 10
Fixed ladder

Ladder Components Most ladders have similar parts, such as feet, side rails, and rungs. The feet on any ladder are the parts of the ladder that rest on the supporting surface and provide the traction to prevent the ladder from slipping. Stepladders, or A-frame ladders, have feet that are stationary, while straight and extension ladders have feet that can rotate, depending on the surface on which the ladder is being used. One side of each foot has rubber for use on surfaces such as concrete, while the other has spikes or cleats, known as safety shoes, for slippery surfaces such as ice or compacted snow. The side rails of all ladders support the rungs, and may be used for gripping while climbing. Safety information labels are located on the side rails. The rungs of the ladder provide the climbing surface for the worker's feet and hands. Stepladders typically have a tray at the top of the ladder to hold tools and work supplies. The bracing and spreaders keep the stepladder base locked in place. Extension ladders have extension locks that securely hold the fly sections, the extendable parts of the ladder, together. When the extension is raised, each extension lock is folded back to allow the free movement of the rails. Once the desired height is reached, the locks are folded back over the lower rung and secured into place. The ladder is equipped with a rope and pulley to adjust the extension from the ground level, should it need to be readjusted after it has been raised. Figure 11 shows typical ladder components.

FIGURE 11
Typical ladder components



Ladder Length

A ladder must be long enough to properly serve its purpose, and using a ladder that is too long or too short can be dangerous. For example, a straight ladder is too long if the ceiling height prevents the ladder from being set up properly at a 4:1 ratio. The 4:1 ratio means that for

FIGURE 12
Proper ladder setup

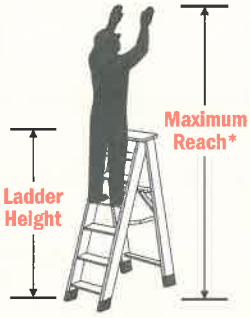
every four feet of vertical travel, the base should be one foot away from the wall. In most cases, workers can check for proper ladder angle by standing with their feet touching the base of the ladder and their arms extended with their hands touching the rungs, as shown in Figure 12. An extension ladder is too long if the ladder extends more than 3′-0″ beyond the edge of the upper support point. This is because the portion of the ladder that extends above the upper support point can act like a lever and cause the base of the ladder to move or slide out.

OSHA and OH&S require that a label indicating the highest safe standing level, be placed on all ladders. When using a stepladder, standing on the top cap or the step below the top cap to reach elevated work is not permitted because this may cause a worker to lose their balance and fall. A chart showing how to choose the proper ladder length is shown in Figure 13.

FIGURE 13
Choose the Proper Length

CHOOSE THE PROPER LENGTH

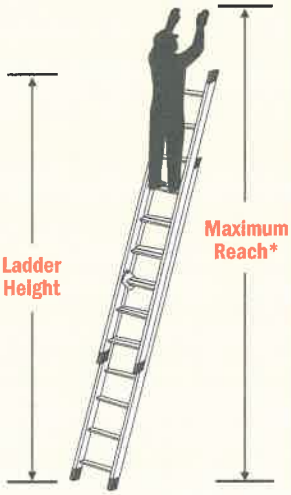
STEPLADDER



LADDER HEIGHT	MAXIMUM REACH*
3 ft. (0.9 m)	7 ft. (2.1 m)
4 ft. (1.2 m)	8 ft. (2.4 m)
5 ft. (1.5 m)	9 ft. (2.7 m)
6 ft. (1.8 m)	10 ft. (3 m)
7 ft. (2.1 m)	11 ft. (3.4 m)
8 ft. (2.4 m)	12 ft. (3.7 m)
10 ft. (3 m)	14 ft. (4.3 m)
11 ft. (3.4 m)	15 ft. (4.6 m)
12 ft. (3.7 m)	16 ft. (4.9 m)
14 ft. (4.3 m)	18 ft. (5.5 m)
16 ft. (4.9 m)	20 ft. (6.1 m)

* Assumes a 5.6 ft (1.7 m) person with a vertical 12 inch (30.5 cm) reach.

EXTENSION LADDER



LADDER HEIGHT	MAXIMUM REACH*
16 ft. (4.9 m)	15 ft. (4.6 m)
20 ft. (6.1 m)	19 ft. (5.8 m)
24 ft. (7.3 m)	23 ft. (7 m)
28 ft. (8.5 m)	27 ft. (8.2 m)
32 ft. (9.8 m)	31 ft. (9.4 m)
36 ft. (11 m)	34 ft. (10.4 m)
40 ft. (12.2 m)	37 ft. (11.3 m)

Duty Rating

The **duty rating** of a ladder is the maximum allowable load the device can safely support. Ladders are tested by their manufacturers and assigned a duty rating. This is done to help prevent workers from accidentally overloading a ladder and causing it to fail. The duty rating will be indicated by a label required by safety regulations and standards to be placed on the side of every manufactured ladder. A duty rating label is shown in Figure 14. The following are standard duty ratings assigned to various manufactured ladders:

- Type IAA (Extra Heavy Duty): 375 lb
- Type IA (Extra Heavy Duty): 300 lb

SAFETY TIP

Workers should not assume that a longer ladder has a higher weight capacity, since there is no relationship between a ladder's length and its ability to support weight.

- Type I (Heavy Duty): 250 lb
- Type II (Medium Duty): 225 lb
- Type III (Light Duty): 200 lb

To ensure that a ladder will not be overloaded, a worker must know its duty rating as well as the total amount of weight that will be placed on the ladder. This is done by adding together the weights of the various loads that will be placed on the ladder. If the total weight of these loads exceeds the duty rating of the ladder, then a ladder with a higher duty rating will be required. To determine the total load that will be placed on the ladder, the following are added together:

- worker's weight
- weight of the worker's clothing and protective equipment
- weight of any tools and supplies the worker will be carrying
- weight of any tools and supplies stored on the ladder

FIGURE 14
Duty rating label

Because the combined weight of most workers and their tools will usually be at least 250 pounds, Type II and Type III ladders should not be used on a construction site. A Type I ladder should be the minimum duty rating used on a construction site, and they are commonly used when performing inspections. Type IA ladders can accommodate a worker, tools, and a small amount of materials, such as access panels. Type IAA ladders accommodate a worker, tools, and heavier materials, such as drywall or metal framing material. A chart showing how to choose the right ladder is shown in Figure 15.

FIGURE 15
Choose the Right Capacity

CHOOSE THE RIGHT CAPACITY

Next, consider the **Duty Rating** of the ladder.
It is an indication of the maximum weight capacity of a ladder.

Your Weight
+
The Weight of Your Clothing and Protective Equipment
+
The Weight of Tools and Supplies You Are Carrying

≤ **Ladder Duty Rating**

5 Categories of Ladder Duty Ratings:

Load Capacity	Application	CSA	ANSI
200 lbs./91 kg	Light Duty	Grade 3	Type III
225 lbs./102 kg	Medium Duty	Grade 2	Type II
250 lbs./113 kg	Heavy Duty	Grade 1	Type I
300 lbs./136 kg	Extra Heavy Duty	Grade 1	Type IA
375 lbs./170 kg	Extra Heavy Duty	Grade 1	Type IAA

The Duty Rating of your ladder can be found on the specifications label. Safety standards require a Duty Rating sticker to be placed on the side of every ladder. Do not assume that a longer ladder has a higher weight capacity. There is no relationship between ladder length and weight capacity.

Ladder Inspections and Maintenance

A ladder must be thoroughly inspected by a competent person when it is purchased or brought out of storage, and each time it is placed in service. All ladders include a label with instructions and specifications, and some

FIGURE 16
Labeled ladder

may have a place to write in dates of inspection. See Figure 16. This is done to ensure the ladder is clean and in good working condition. Using a damaged or unclean ladder can be dangerous.

When inspecting a ladder, all components must be carefully checked as follows:

- steps/rungs: loose, cracked, bent, or missing
- rails: cracked, bent, split, or frayed
- labels: missing or not readable
- hardware: loose, broken, or missing
- fasteners: rust, corrosion, loose, or missing
- locks: loose, bent, broken, or missing
- shoes: worn, broken, or missing
- platform: loose, bent, broken, or missing

SAFETY TIP

To prevent accidental use, all defective or damaged ladders must be tagged and removed from the jobsite to be repaired or destroyed.

SAFETY TIP

Ladders should never be painted, as this may hide defects during inspection.

Climbing and gripping surfaces must be thoroughly cleaned if they have been exposed to oil, grease, or slippery materials. Figure 17 shows a rung-to-rail connection being inspected.

Any ladders that have been exposed to fire or other sources of excessive heat may have lost strength and should be removed from service immediately. In addition, ladders that have been exposed to corrosive substances such as acids or alkaline materials may be damaged and should not be used. Broken or bent ladders or those with missing or heavily worn parts are not safe and must be taken out of service. When a ladder is removed from service, it should be clearly tagged to warn others against using it until it is either repaired or destroyed. See Figure 18. Ladders with broken or defective side

FIGURE 17
Inspecting a rung-to-rail connection

FIGURE 18
Damaged ladder with warning

rails must be destroyed to prevent further use and no attempt should be made to repair them.

Transportation and Storage

When ladders are being transported on vehicles equipped with ladder racks, the ladders must be properly supported to prevent bending, sagging, or other damage. Support points should be constructed of materials such as wood or rubber-covered pipe to minimize the effects of vibration, chafing, and road shock. Securing the ladder to each support point, as shown in Figure 19, will reduce damage during transport. No additional weight or other materials should be placed on ladders while they are in storage.

SAFETY TIP

Steps and rungs of ladders should be kept free of grease, oil, wet paint, mud, snow, ice, paper, and other slippery materials. Any such slippery substances should be cleaned from shoes before climbing onto a ladder.

FIGURE 19
Secured ladder

SELF CHECK

1. Why are ladders often taken for granted?
2. List three materials commonly used for constructing ladders.
3. List and define three common ladder types often used in construction.
4. List the three ladder duty ratings typically found on construction sites and list the weight each can safely support.
5. Why are regular ladder inspections and maintenance important?

2 Manufactured Ladders

Most of the portable ladders used on construction sites are manufactured rather than job-built. Wood, fiberglass, and aluminum factory-built ladders are available in a wide range of prices, lengths, and duty ratings. The most common types used in construction are stepladders and extension ladders.

Before using a ladder, the installer should consult the manufacturer's labels to verify that the appropriate ladder has been selected for the task. The worker should then perform a visual inspection to confirm the ladder is not damaged and is in good working order.

When working from a ladder, work should only be performed within the immediate area where the worker can comfortably and safely reach. Once work has been completed in one section, the worker should climb down from the ladder and then move it to the next section. No tools or materials should be carried up the ladder by hand. Any items that cannot be secured in a tool belt must be handed or hoisted to the installer once they have climbed the ladder.

Manufacturers' Safety Labels

Manufacturers are required to place warning and information labels on their ladders to provide details on how to properly and safely use them. See Figure 20. Before using a ladder, all the information on the labels should be reviewed. Warning labels will provide information regarding safe usage of the ladder, as well as information about the maximum height the ladder can reach and the maximum weight it can support.

Stepladders and Platform Ladders

One of the most commonly used manufactured ladder is the stepladder. It has flat steps and a hinged base that allows it to be used when a freestanding ladder is required. Although nonadjustable in length, a stepladder offers a highly portable, self-supporting, and relatively stable means of reaching overhead work areas. Figure 21 shows a stepladder being used for construction work.

A platform ladder is a type of stepladders with a platform and guardrail at the highest standing level, as shown in Figure 22. Platform ladders are used when a freestanding ladder is required and must provide additional stability

FIGURE 20
Manufacturers' safety labels

FIGURE 21
Stepladder in use

FIGURE 22
Platform ladder

FIGURE 23
Ladder with steps on both sides

or security such as when extensive work from the ladder is required. It is safer to use a platform ladder than a stepladder. A top rail guard is a bar that is located above the platform and is used to help stabilize a worker standing on the platform. Like other stepladders, platform ladders are nonadjustable. Platform heights range from 3′-0″ to 10′-0″.

Safe Use

Like all ladders, stepladders and platform ladders must be used with care and attentiveness, while closely following all applicable safety rules and regulations. In some situations, it may not be possible to safely use a stepladder or platform ladder at all. These ladders require level ground to support all four side rails. If these conditions do not exist in the work area, a stepladder or platform ladder should not be used for the task.

When using a stepladder, the top two steps should never be stood on, the ladder should never be straddled, and an unopened stepladder should never be climbed. When climbing a stepladder, only the working side should be used. However, special stepladders are available with steps on both the front and rear, as shown in Figure 23, and can be used by two workers at once. A stepladder or platform ladder must not be used unless the ladder base is spread fully open and the spreaders locked. See Figure 24. The braces on the rear of a stepladder are not intended for climbing or standing and must not be used for those purposes.

Some manufacturers have designed stepladders that will allow the user to securely lean the ladder against flat wall surfaces, wall corners, poles, and wall studs by using a uniquely designed notch at the top of the ladder. See Figure 25. These ladders make use of an engineered latch that locks the rear

FIGURE 24
Locked spreaders

FIGURE 25
Stepladder with notch

rails to the front rails to stabilize the ladder when they are leaning. They can also be used as conventional stepladders.

FALL AWARENESS SCENARIO

A commercial carpenter died in a completely avoidable tragedy when he fell off an 8′-0″ stepladder. The carpenter was using the ladder to complete some finish work around a soffit on the exterior of a newly built, single-story addition to a preexisting building. The worker was part of a three-man crew and was in visual contact with the other two workers. Coworkers observed him descending the ladder while holding tools in his right hand, and watched the worker fall to the concrete foundation at the foot of the ladder. The worker suffered significant head trauma, several broken ribs, and a punctured lung. The carpenter was pronounced dead at the hospital.

- How could this incident have been prevented?
- Do you know anyone who has fallen from a ladder? How did it happen?

Straight Ladders and Extension Ladders

Straight ladders and extension ladders are similar and are used in much the same way. The obvious advantage of an extension ladder is its adjustable height. Unlike a stepladder that requires level support for all four of its feet, a straight ladder or extension ladder needs level ground support at only two points. However, these ladders require top support, such as tying off to guardrails, whereas stepladders do not. When using a straight ladder or extension ladder on uneven surfaces, ladder levelers may be used to achieve equal rail support. A ladder leveler is shown in Figure 26. Best practice is to tie off the top of the ladder at the contact point, typically with wire or rope as shown in Figure 27, and the ladder's base should be secured using rope,

SAFETY TIP

To prevent a fall while climbing or descending a ladder, workers should maintain three-point contact—two hands and a foot or two feet and a hand in contact with the ladder at all times.

SAFETY TIP

Stepladders must not to be used like a straight ladder or single ladder or in a partially opened position.

SAFETY TIP

A worker should never attempt to move a stepladder while standing on it. The only safe way to move a stepladder while it is in use is to descend, relocate, and then re-climb the ladder.

SAFETY TIP

To avoid loss of balance, workers should never step above the highest standing level indicated by the manufacturer.

SAFETY TIP

Stepladders must not be used on ice, snow, or slippery surfaces unless suitable means to prevent slipping are available and properly used.

FIGURE 26
Ladder leveler

FIGURE 27
Top of ladder tied off

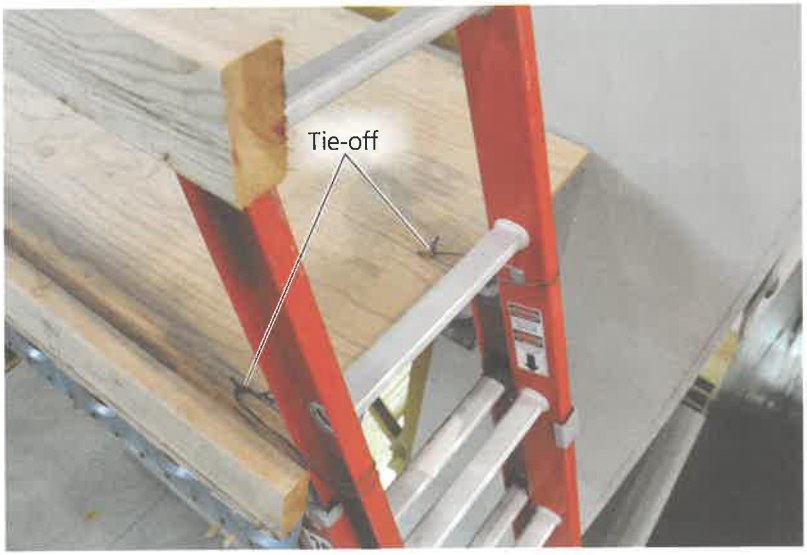


FIGURE 28
Secured ladder base

FIGURE 29
Multi-use ladder

scrap lumber or metal stakes, and wire to increase stability, as shown in Figure 28.

Length is an especially important consideration when using straight ladders, because they cannot be adjusted. If the ladder is too tall, it may not be possible to set up the ladder at the proper 4:1 ratio. In such cases, a shorter ladder should be selected to prevent the bottom of the ladder from sliding out.

A ladder that is too long may create a gap between the worker and the point on a wall where the work must be performed. For example, a 14′-0″ straight ladder cannot be used to work on a wall below a level of about 10′-0″ because that would place the worker too far from the wall. In most cases, the lower portion of the wall can be reached from the ground up to a height of about 7′-0″, which leaves a gap between the 7′-0″ and 10′-0″ levels where a worker would have difficulty reaching the wall. To reach the wall in the gap area, a worker may need to use a stepladder or other shorter ladder. Some manufacturers now have multi-use ladders, as shown in Figure 29, that can be used as an extension ladder or a stepladder.

Attempting to adjust a ladder while it is occupied is unsafe and could cause an accident. Once the ladder height has been determined, the ladder should be extended to the proper length and the extension locks firmly engaged, as shown in Figure 30. If the ladder is not adjusted to the proper length and needs to be readjusted, the ladder is equipped with a rope and pulley to adjust the extension from the ground level. The rope is attached to a rung near the bottom of the adjustable length of ladder and runs through a pulley near the top of the nonadjustable ladder section. The excess rope hangs freely to allow the worker to pull on the rope to raise or lower the adjustable portion of the ladder to the correct height.

SAFETY TIP

To prevent accidents and injuries, an extension ladder should never be adjusted while the ladder is occupied.

FIGURE 30
Engaging extension lock

Safe Use

The safety rules that must be followed when using a straight ladder or an extension ladder are much the same as those for other ladders. For example, workers standing on these ladders must avoid overreaching to prevent tipping them sideways. A worker should never attempt to move a ladder while standing on it and should not attempt to move from one ladder to another.

Ladder use requires maintaining a 4:1 vertical-to-horizontal ratio. For every 4′-0″ of the ladder's height, the ladder's base should be 1′-0″ away from the structure it is leaning against. The ladder's feet should be level when the ladder is positioned correctly. Manufactured ladders have a label with an angle indicator, as shown in Figure 31, to help determine the correct angle. The feet of the ladder should be secured by staking and wiring the bottom to prevent the ladder from kicking out and falling when climbed.

The top of the ladder must reach high enough above the landing to allow the user to safely exit. Proper placement involves both rails being supported equally and extending at least 3′-0″ above the upper landing surface. Walk-through ladder extensions can be attached to the top of the ladder to provide safe exit from the top of the ladder. Figure 32 shows ladder extensions and how they are used. Extension ladders should always be positioned and tied off

FIGURE 31
Angle indicator

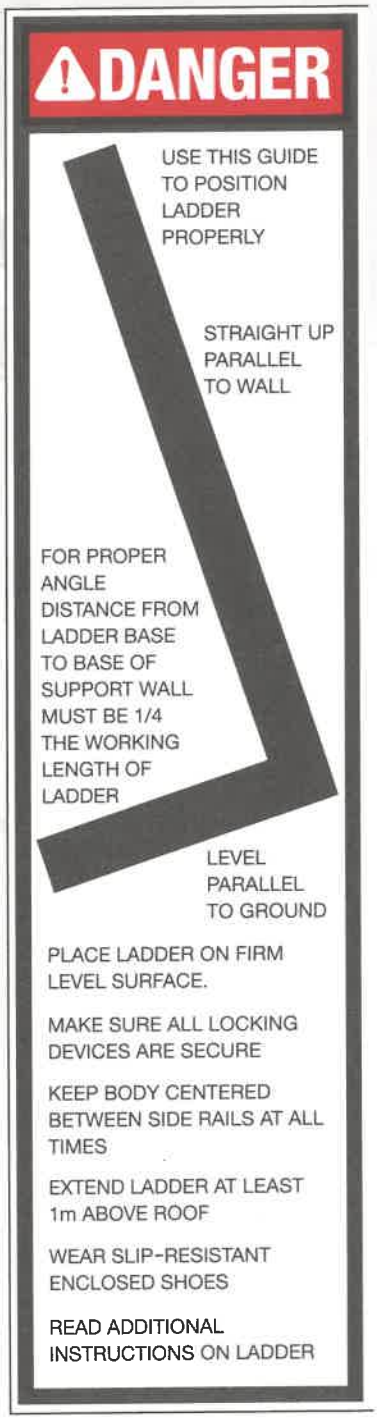


FIGURE 32
Ladder with walk-through extensions

SAFETY TIP

It is unsafe to separate an extension ladder and use the sections independently. The manufacturers do not design them for single use.

FIGURE 33
Hoisting items

for maximum stability. The ladder should be secured to the structure near the top of the ladder. Instead of workers carrying tools, materials, and other objects while climbing straight ladders or extension ladders, tool bags or ropes should be used to hoist these items. See Figure 33. Ladders should never be tied or fastened together in an attempt to attain a greater length. The top of a straight or extension ladder must be placed with the two side rails equally supported, unless the ladder is equipped with a single-support attachment, as shown in Figure 34.

FIGURE 34
Single-support attachment

SAFETY TIP

To maintain three-point contact, do not carry any materials when ascending or descending ladders.

SAFETY TIP

A damaged ladder should be tagged "Defective/Do Not Use" and reported to a supervisor so that it can be removed from service.

SAFETY TIP

A ladder should never be set up in front of a door, unless the door is locked and secured or a guard is posted.

FALL AWARENESS SCENARIO

A 35-year-old journeyman carpenter fell 12 feet from a metal and fiberglass extension ladder. The victim and a coworker were finishing up at the jobsite after a soffit repair in a bank building. The workers separated an extension ladder into two halves. The lower section, with proper feet attached, was positioned against a roof over the drive-in banking lanes. The upper section, with rounded end caps, was used by the victim on a small section of soffit over an employee entrance. The victim completed the task on the soffit and returned with the ladder to the drive-in lanes and placed it against the roof and beside the ladder's lower section. The victim then retrieved some tools and a push broom and set them beside the ladder and proceeded to climb the extension portion of the ladder. He was approaching the roof line when the ladder slid outward at the bottom. The victim fell with the ladder, striking his head on the end of the broom stick, inflicting head trauma. He was taken by ambulance to a local hospital, then later transferred to a regional trauma center where he died the following day.

- How could this incident have been prevented?
- Do you know anyone who has fallen from a ladder? How did it happen?

Ladder Setup

Proper ladder setup is essential because improper setup may lead to ladder damage and place excessive physical strain on the worker. The following procedure details the process of properly setting up and taking down an extension ladder.

PROCEDURE

How to Set Up an Extension Ladder

1. Place the ladder on a firm, level surface with the base resting near the bottom of the structure the ladder will be leaning against and the top pointing away from the wall, as shown in Figure 35.
2. Starting at the top of the ladder, the end of the ladder is lifted over the head of the worker, as shown in Figure 36, who will then walk under the ladder to the wall while moving hands from rung to rung.

(continued)

FIGURE 35
Staged ladder

FIGURE 36
Lifting a ladder

SAFETY TIP

If there is any danger of slipping, the base of the ladder should be braced with stakes or boards placed against the feet.

TRADE TIP

The metal bearings of extension ladder extension locks and pulleys should be lubricated at regular maintenance intervals or whenever needed.

TRADE TIP

Extension ladder ropes should be checked regularly to ensure they are in good condition. Badly worn or frayed ropes should be replaced immediately.

PROCEDURE *(continued)*

3. Pull the base of the ladder out so the distance from the wall maintains the 4:1 height-to-base ratio, as shown in Figure 37.
4. Take the rope and pull it through the pulley until the extension is at the desired height. See Figure 38. Ensure the extension locks are fully engaged.
5. Reset the ladder base so it is at a 4:1 ratio.
6. Secure the ladder's base so it does not move; use rope, scrap lumber or metal stakes, and wire.
7. Readjust for height, if needed.
8. Secure the extension locks, as shown in Figure 39.
9. Secure the top of the ladder by tying it to a solid contact point. See Figure 40.
10. Reverse the setup process when taking down the ladder. It is important to remember that the worker will be walking backwards, so the area must be carefully checked for obstacles. The ladder must be lowered slowly to keep it under control and prevent it from falling.

FIGURE 37
Adjusting the base

FIGURE 38
Adjusting the ladder

FIGURE 39
Securing the extension lock

FIGURE 40
Ladder secured at the top

SELF CHECK

1. What is the difference between a stepladder and a platform ladder?
2. List five important safety rules that must be followed when using stepladders or platform ladders.
3. Explain how to properly set up a straight ladder or extension ladder.
4. What is the proper ratio for a straight ladder or extension ladder set against a wall?
5. Describe how to adjust an extension ladder.

3 Job-Built Ladders

In many cases, a manufactured portable ladder will not be necessary because it can be replaced by a job-built ladder, which is a wooden ladder built at the construction site to provide access or to serve as a work platform. Made for a single purpose, often by the same workers who will be using it, a job-built ladder may be configured to a specific jobsite task. These ladders are temporary and are used only until a given phase of work has been completed. A typical job-built ladder is shown in Figure 41.

FIGURE 41
Job-built ladder

Assembling a Job-Built Ladder

A job-built ladder can be constructed using standard carpentry tools and materials available at the construction site. However, if these ladders are not built properly, the workers

who use them may risk permanent injury or death from falls, electrical shocks, and other incidents. To promote safety, the construction of job-built ladders is governed by OSHA, OH&S, and other local, state, provincial, and federal regulations, as well as by industry standards. These regulations and standards include, but are not limited to, the following:

- Construction-grade lumber should be used for all side rails and other wooden components.
- Side rails of single-cleat ladders up to 24′-0″ long should be made with at least 2″ × 6″ nominal stock lumber.
- Side rails should be continuous unless the splices are the same strength as a continuous rail of equal length.
- The width of single-rung ladders should be at least 16″, but not more than 20″, between the rails, measured inside to inside.
- Rails should extend above the top landing between 36″ and 42″ to provide a handhold for mounting and dismounting, and cleats must be eliminated above the landing level.
- Side rails of ladders that could contact energized electrical equipment should be made from nonconductive material.
- Ladders should be kept free of slippery materials.
- Cleats should be equally spaced 12″ on-center from the top of one cleat to the top of the next cleat.
- Cleats should be fastened to each rail with three 12d common wire nails, which should be nailed directly onto the smaller surfaces of the side rails.
- Making cuts in the side rails to receive the cleats is not advisable as it weakens the wood.
- Cleats should be at least 1″ × 4″ for ladders 16′-0″ to 24′-0″ in length.
- Filler blocks should be made of the same dimensional lumber as the cleats.
- Filler blocks are inserted between cleats.
- A competent person must visually inspect job-built ladders for defects once they have been completed.

SAFETY TIP

Job-built ladders must be inspected before each work shift for damage and wear.

FIGURE 42

Inspecting a job-built ladder

Inspecting a Job-Built Ladder

Once completed, job-built ladders must be inspected by a competent person to ensure they are safe and have been constructed according to applicable regulations and standards. The inspection must be completed before the job-built ladder is used for the first time. As with all ladders, job-built ladders must be inspected by a competent person on a regular basis while they remain in use and after any incident or other event that may affect the ladder's performance and safety characteristics. The defects the competent person will look for include structural damage, broken or split side rails, and missing cleats or steps. Figure 42 shows a competent person inspecting a job-built ladder for defects and safety issues.

Using a Job-Built Ladder Safely

Job-built ladders can provide a convenient way to access elevated work areas, and they must never be taken for granted. The fact that these ladders have been built by members of an on-site work crew does not mean they are safe. All ladders are dangerous and workers should use them with care. The following safe use and practices for job-built ladders are recommended:

- Wooden surfaces of the ladder should be smoothed to reduce puncture or laceration injuries and to prevent snagged clothing.
- Job-built wooden ladders should have spliced side rails at an angle so that the horizontal distance from the top support to the foot of the ladder is one-eighth of the working length of the ladder.
- Job-built wooden ladders should be able to support at least four times the maximum intended load.
- Ladders should be used only for the purposes for which they were designed.
- Ladders should be set up only on stable and level surfaces, unless they have been secured to prevent accidental movement.
- Workers should face the ladder when climbing up and down.
- When climbing or descending a ladder, workers should maintain three-point contact: two hands and one foot or two feet and one hand.
- Good housekeeping must be practiced in order to ensure areas around the top and bottom of ladders are kept free of obstructions.
- Ladders should never be painted, as this could mask damage or defects.
- Workers should not carry tools, materials, or other objects when climbing a ladder, as this may cause a worker to lose their balance and fall.
- Job-built ladders must not be placed under excessive loads or exposed to impact damage.
- Ladders must be kept free of oil, grease, and other slippery materials that may present a hazard.

TRADE TIP

Apply skid-resistant tape on the rungs of a job-built ladder to help prevent slipping.

SELF CHECK

1. List five key safety requirements when constructing a job-built ladder.
2. Who is responsible for inspecting job-built ladders?
3. Which way should a worker face when climbing up and down a ladder?

4 Fixed Ladders

A fixed ladder is a vertical ladder mounted permanently to an existing structure. See Figure 43. Fixed ladders are often guarded by enclosures that prevent workers from falling backward off the ladder. Two common types of fixed ladder enclosures are cages and wells. A **cage** is an enclosure

FIGURE 43
Fixed ladder

FIGURE 44
Cage

SAFETY TIP

The fall protection industry has largely recognized that cages do not provide any type of protection from falling and can contribute to injury.

fastened to the side rails of a fixed ladder or to the structure to encircle the climbing space and help prevent climbers from falling. Cages are typically found on fixed ladders used for interior or exterior roof access. An example of a cage is shown in Figure 44. A *well* is a permanent complete enclosure around a fixed ladder attached to the walls of the structure. Ladder wells are typically found on silos and in elevator pits. An example of a well is shown in Figure 45.

FIGURE 45
Well

In the past, OSHA considered cages and wells to be adequate protection on ladders of most lengths. However, current regulations and industry standards have changed. The agency now requires a worker to be protected by a personal fall arrest system or ladder safety system when climbing ladders extending 24′-0″ or more. By November 18, 2036, all fixed ladders, regardless of installation date, must have a ladder safety system or PFAS. Although not a requirement yet in Canada, the CSA recommends that workers use a PFAS when climbing a fixed ladder.

Ladder Safety Systems

A ladder safety system provides a continuous attachment to a fixed ladder and is designed to eliminate or reduce the possibility of a worker falling off the ladder. These systems allow a worker to keep both hands free for climbing. They are designed to follow the user along a lifeline while ascending or descending, will instantly lock in the event of a fall. Ladder safety systems are available from manufacturers to retrofit and update existing ladders with cages and wells to meet the new standards. Figure 46 shows two common ladder safety system retrofits.

FIGURE 46
Ladder safety system retrofits: cable and rigid rail

SELF CHECK

1. Describe a fixed ladder.
2. What is a cage and where is it typically found?
3. What is a well and where is it typically found?

5 Stairways

Stairways provide safe access from one working level to another. Temporary stairways are built for the purposes of workplace safety and for workers' movement during construction. These stairways must have landings to provide a rest area for workers carrying tools or materials. Stair rails are needed along each unprotected side or edge of the stairways for safety. A handrail is required for a handhold or support. Temporary stairways can be job-built on-site, such as wooden stairs used to provide temporary access to various levels within a building. See Figure 47.

Another type of temporary stairs is actually a permanent part of a finished building. However, they are classified as temporary because the treads are filled with removable materials and are used by construction workers. Metal pan landings and treads are secured in place and temporarily filled until the finished product, typically concrete, is

FIGURE 47
Building temporary stairs

FIGURE 48
Metal pan stairs

SAFETY TIP

Always have one hand on the stair railing to maintain stability when moving up or down stairs.

SAFETY TIP

Stairways should be clear of debris and extension cords and cables.

SAFETY TIP

When moving heavy items up or down stairs, use a mechanical device to help eliminate falls, stress, or strains.

installed. Figure 48 shows metal pan stairs being placed to be filled.

Stairway Hazards

A combination of improper riser and tread design, inadequate lighting, poor visibility, and lack of attention are just a few of the things that can contribute to stairway slips, trips, and falls. The majority of stairway falls result from a loss of balance. Another common factor contributing to falls on stairways is not using the handrails.

Because stairway accidents can cause severe injury and even death, OSHA and OH&S have put regulations in place for stair construction. These design regulations can help reduce the potential for missteps by providing a means for stair climbers to retrieve their balance should they slip. However, even the best design cannot eliminate falling hazards entirely. Some incidents can be caused by inattention, unsafe behavior, and inappropriate footwear. Safety tips and recommendations for climbing stairs include the following:

- Never run up or down stairs.
- Never text or read papers while using stairs.
- Focus on the stairs, not conversations or other distractions that may be present.
- Always look straight ahead when using stairs.
- Take one step at a time.
- Get help when something must be carried up or down stairs.
- Use extra caution when using outside steps if it is raining or snowing.

Becoming Distracted Being distracted is a common unsafe behavior that often leads to an incident. Common distractions include talking or texting on a phone, checking the time, or reading while climbing or descending stairs. Figure 49 shows a clearly distracted worker who, without realizing it, may be putting his life at risk.

Carrying Loads One of the most common risky behaviors on construction site stairways is that of carrying loads up or down the stairs. Carrying a load at head height is distracting, blocks vision, makes it difficult to see where the feet are being placed, and since the hands are full, prevents the worker from grasping a handrail, as shown in Figure 50. It may also throw the person carrying the load off-balance. At least one hand should be free when using stairs.

Failure to Use Handrails Among the most basic and effective safety devices, a handrail can prevent most stairway accidents when used properly. A **handrail** is a stair system component designed to be grasped by hand to

FIGURE 49
Distracted worker on stairs

FIGURE 50
Carrying a load in an usafe manner ascending steps

provide stability and support while ascending or descending stairs. Using a handrail is simple: if a worker slips, trips, or begins to fall while descending a stairway, grabbing the handrail can break the fall and help prevent serious injury. A typical stairway handrail is shown in Figure 51.

Failure to Recognize Unsafe Conditions Unsafe conditions contribute to many accidents, which makes it extremely important to be able to recognize them and take them into consideration. For example, extra precaution should be taken when using stairs that have been dampened by rain or spills, or that have iced over. See Figure 52.

FIGURE 51
Stairway handrail

FIGURE 52
Icy stairs

FIGURE 53
Worker who has fallen due to stairway clutter

Figure 53 shows a worker who has fallen while attempting to climb a cluttered stairway.

Stairway Rules and Requirements

OSHA and OH&S stairway requirements state that permanent and temporary stairways must have landings to provide a rest area for workers carrying tools or materials. A **stair rail** is a barrier erected along the exposed or open side of stairways to prevent workers from falling to a lower level. Stair rails are needed for safety along each unprotected side or edge on stairways. A handrail is required for a handhold or support. Other OSHA and OH&S requirements include the following:

- Stairways that will not be a permanent part of the building under construction must have at least one landing, no less than 30″ deep and 22″ wide, at every 12′-0″ of vertical rise.
- Stairways must be positioned at least 30°–50° from the horizontal.
- Variations in riser height or stair tread depth must not exceed ¼″ in any stairway system, including any foundation structure used for a stair tread.
- Doors and gates opening directly onto a stairway must have a platform that extends at least 20″ beyond the swing of the door or gate.
- Stairway parts must be free of dangerous projections such as protruding nails.
- Slippery conditions on stairways must be corrected immediately.
- Workers must not use spiral stairways that will not be a permanent part of the structure.
- Metal pan landings and treads must be secured before filling.
- Metal pan landings and treads must be filled with concrete before use.
- For temporary use, the metal pans and landings must be filled with a non-flowable material such as wood. All treads and landings must be replaced when worn below the top edge of the pan.
- Skeleton metal frame structures and steps should not be used unless the stairs are fitted with secured temporary treads and landings.

Stair Rail Requirements

Stair rails are an important safety feature that must be included in every construction site stairway. For safety reasons and to comply with OSHA and OH&S regulations, stair rails must meet the following requirements:

- Stairways with four or more risers or that rise more than 30″ must have stair rails along each unprotected side or edge. When the top edge of a stair rail system also serves as a handrail, the height of the top edge must be no more than 37″ and no less than 36″ from the upper surface of the stair rail to the nose of the tread.
- Stair rails must not be less than 36″ in height.
- Stair rail systems and handrails must have smooth surfaces to prevent injuries such as punctures or lacerations and to prevent clothing from snags.

- Ends of stair rail systems and handrails must be built to prevent dangerous projections such as rails protruding beyond the end posts of the system.
- Unprotected sides and edges of stairway landings must have standard 42″ guardrail systems.
- Intermediate vertical members, such as the balusters used as guardrails, must not be more than 19″ apart.
- Any other intermediate structural members must be installed so that no openings are more than 19″ wide. Screens or mesh must extend from the top rail to the stairway step and along the opening between top rail supports.

FIGURE 54
Intermediate members

Midrail Requirements Midrails, screens, mesh, intermediate vertical members, or equivalent intermediate structural members must be provided between the top rail and stairway steps of the stair rail system. Figure 54 shows intermediate members.

Handrail and Top Rail Requirements By providing workers or anyone else climbing or descending a stairway with secure support in case of a slip or loss of balance, handrails and top rails can help prevent many falls and other incidents. They must be properly installed and maintained in order to provide this protection. Handrails and top rails must meet the following requirements:

- Handrails and top rails of the stair rail systems must be able to withstand at least 200 pounds of weight applied within 2″ of the top edge in any downward or outward direction at any point along the top edge.
- Handrails must be no more than 37″ high and no less than 30″ from the upper surface of the handrail to the nose of the tread. Figure 55 shows proper handrail placement.
- Handrails must provide an adequate handhold for workers.

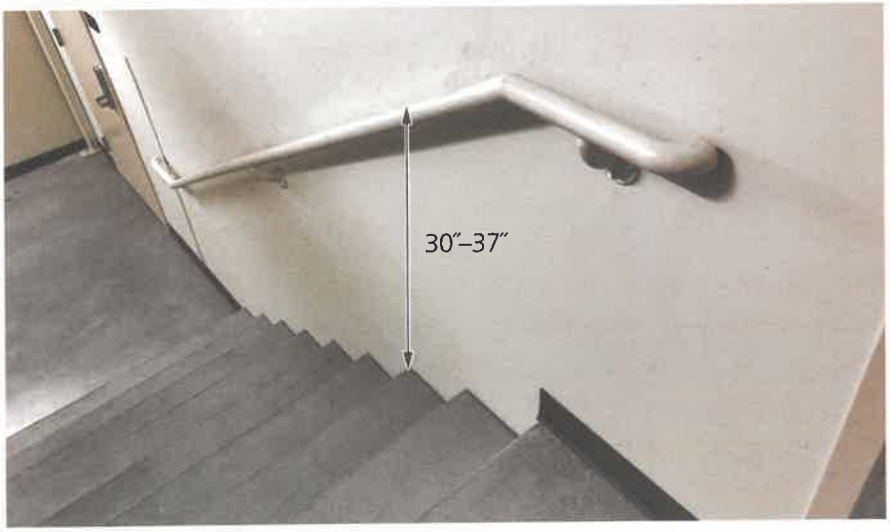


FIGURE 55
Proper handrail placement

- Temporary handrails must have a minimum clearance of 3″ between the handrail and the wall, stair rail system, or other objects.
- Stairways with four or more risers, or with risers more than 30″ above a walking surface, must have at least one handrail.
- Winding or spiral stairways must have a handrail to prevent use of areas where the tread width is less than 6″.

SELF CHECK

1. Why is it especially dangerous to carry loads when climbing stairs?
2. List and describe three types of unsafe conditions that require extra caution when climbing or descending stairs.
3. List five key safety rules and requirements that apply to temporary stairways.
4. What is a stair rail and what role does it play in stairway safety?
5. List five key handrail and top rail safety requirements.

6 Scaffolds

A **scaffold** is any temporary elevated platform or suspended work platform for workers, tools, and materials. Scaffolds are used for many purposes, and one of the most important of these is to allow work to be performed above the ground or floor. Working at elevation increases the chance that a fall will cause permanent injury or even death. However, falls can occur at any height and every fall has the potential of causing serious injury. For this reason, fall protection is a prime concern when erecting or working on scaffolding. A typical supported scaffold is shown in Figure 56 and a typical suspended scaffold is shown in Figure 57.

The work platforms of scaffolds are protected by guardrails that help prevent falls. In most cases, the scaffold will have gates that provide platform access from ladders or stairways. Scaffold platforms may also have toeboards and mesh netting, as shown in Figure 58, to help keep tools and materials from sliding or falling off the edge and possibly injuring construction personnel or bystanders below. Workers on elevated scaffold platforms should use active fall protection systems that include a secure anchorage, full-body harness, and connector. Figure 59 shows workers on a scaffold wearing a full-body harness attached to an anchored connector.

Both the erection of scaffolds and the fall safety techniques that must be used to protect scaffold workers are regulated by federal, state, provincial, and local agencies in the United States and Canada. While regulations vary from place to place, most require scaffolding that is higher than 10′-0″ to offer both passive and active fall protection systems. In some areas, requirements may be stricter and apply to scaffolding 7′-6″ or less in height. The most stringent local, state, provincial, or federal regulations should always be followed. Additional information on scaffolds and scaffold safety can be found in the UBC Scaffolding 1 and Scaffolding 2 workshops.

SAFETY TIP

Always keep scaffolds free of debris to prevent trip hazards and overloading.

SAFETY TIP

To prevent tripping hazards, access and egress points on scaffolds should be kept clear at all times.

SAFETY TIP

Always use tool lanyards when working on scaffolds to prevent tools from being dropped on workers below.

FIGURE 56
Supported scaffold

FIGURE 57
Suspended scaffold

FIGURE 58
Toeboards and mesh netting

FIGURE 59
Active fall protection

FALL AWARENESS SCENARIO

A two-man crew was installing drywall inside a hospital addition. One of the crew, a 31-year-old male, was standing on a 6′-0″ mobile scaffold installing drywall on the top section of the room. His coworker heard a sound, looked over, and saw the scaffold falling over with the victim entangled in the frame. The scaffold crashed into the concrete floor. He immediately went to get help. The victim was hospitalized but died from his head injuries the following day. The aluminum scaffold board used as a work platform was not designed for the scaffold frame. It was too narrow, which led to the scaffold not being fully planked. In addition, the scaffold was not equipped with a guardrail and the wheels were not locked.

- How could this accident have been prevented?
- Have you ever known anyone who fell from a mobile scaffold?

SELF CHECK

1. What are scaffolds and what passive safety features do they often include?
2. According to OSHA and OH&S regulations, scaffolds above what height require the use of both passive and active fall safety systems?

7 Mobile Elevating Work Platforms (MEWPs)

SAFETY TIP

Never move an elevated MEWP with workers on the platform, unless the equipment has been specifically designed for this type of operation. To do so may cause the equipment to become unstable, fall over, and cause injury.

A **mobile elevating work platform** (**MEWP**) is a mechanical device used to provide temporary access for personnel or equipment to elevated work areas. A MEWP is designed to move workers and their tools and materials to work areas that would otherwise be difficult to reach. Most MEWPs have extendable or articulating mechanisms that can move workers vertically, horizontally, or perform a combination of these movements. Several types of MEWPs are available, including manually propelled lifts, boom lifts, and scissor lifts. Examples of these common MEWPs are shown in Figures 60–62.

MEWP Safety

MEWPs can offer a safe means of accessing work at heights, but only when properly maintained and operated by qualified personnel who are familiar with their use. MEWP operators and platform workers must be appropriately monitored by competent and knowledgeable supervisors. Safety on the jobsite is always the most important responsibility of workers and their supervisors.

FIGURE 60
Manually propelled lift

FIGURE 61
Boom lift

FIGURE 62
Scissor lift

A jobsite fall protection plan may include the use of MEWP equipment. This equipment can actually be used as a tool to prevent falls since it includes a platform that is fully protected with guardrails. However, OSHA, OH&S, and other government agencies require fall protection systems as well as guardrails for MEWP workers. These systems should prevent falls or protect occupants who do fall, while minimizing interference with work activities. OSHA and OH&S regulations state that a fall arrest system must be rigged such that an employee can neither free fall more than 6′-0″ nor

SAFETY TIP

Personal fall arrest equipment is required when using a MEWP. Lanyards, safety harnesses, snap hooks, and fall protection equipment must be worn by workers.

make contact with any lower level. The location of anchorage points on MEWP equipment may vary. Anchorage points can be located anywhere from the platform floor to the top guardrail.

Lanyard Anchorages on MEWPs

Only anchorages that have been approved by the MEWP manufacturer should be used to secure lanyards. The competent person and manufacturer specifications determine the type of lanyard to be used. These may be integrated into the work platform structure or supplied by the manufacturer for attachment to the platform. According to the American National Standards Institute/Scaffold and Access Industry Association (ANSI/SAIA) A92 Standards, only one person may be attached to a single anchorage unless the anchorage has been rated for more than one person. The number of allowable lanyard attachments on a single anchorage is typically indicated near the anchorage and in the MEWP operator's manual.

When working from a MEWP, workers must be protected from falls. MEWPs have a guardrail or fall arrest anchorage point in place to prevent falls and protect workers. The guardrails or guardrail system should not be used as a lanyard anchorage point unless specifically designed to do so by the manufacturer. The operator's manual supplied by the manufacturer will specify whether this is permissible. Most requirements for fall protection anchorages can be determined from the regulations outlined by OSHA, OH&S, and ANSI. Factory-installed or manufacturer-recommended PFAS anchorage points must be used. A manufactured anchorage point is shown in Figure 63. The following fall protection systems are commonly used to protect workers on MEWPs.

FIGURE 63
Manufactured anchorage point

Fall Restraint and Fall Arrest Using a Lanyard With an Adjuster

When occupants need to move within the platform, a lanyard with an adjuster may be the best option. These devices are available in various

lengths and allow the occupant to use either a fall restraint system or a fall arrest system, depending on the adjusted length of the lanyard. When a lanyard with an adjuster is used as a fall arrest system, it should include a deceleration device, also known as a shock absorber, to reduce impact forces on the body. A lanyard with an adjuster is shown in Figure 64.

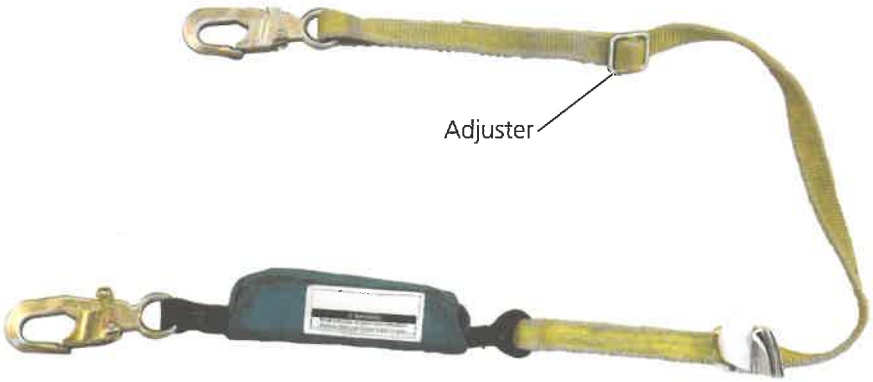


FIGURE 64
Lanyard with adjuster

Fall Restraint Using a Short Lanyard A fall restraint system using a short lanyard consists of a platform anchorage, body harness, and a lanyard connector and is designed to protect workers from falls and prevent them from being ejected off of the platform. The connection from the anchorage to the body harness is the lanyard. The length of the lanyard is a factor and may determine whether it can prevent a fall. The location of the anchorage point on the MEWP and the height of the occupant must be considered when determining the appropriate lanyard length. A short-length lanyard may be used to provide the restraint needed to protect workers from the catapult effect that may cause them to be thrown from the platform. Accidents of this kind often occur while a MEWP is moving. A short lanyard fall restraint system is shown in Figure 65. MEWP manufacturers, employers, or local regulations may require the use of a fall restraint system.

FIGURE 65
Short lanyard system

Fall Restraint and Fall Arrest Using a Twin-Legged Lanyard Twin-legged lanyards are equipped with dual lanyards and may have a shock absorber. It is important that the worker does not attach both snap hooks to the same anchorage point at the same time, unless this is allowed by the manufacturer. Twin-legged lanyards are used to ensure workers are attached to a safe anchorage point at all times. This is known as 100 percent tie-off. Attaching one snap hook to a safe anchorage before removing the other snap hook is the best safe practice when exiting a MEWP at height, if exiting at height is allowed. Many employers and local regulations require 100 percent tie-off. A twin-legged lanyard is shown in Figure 66.

FIGURE 66
Twin-legged lanyard

Fall Restraint and Fall Arrest Using Self-Retracting Devices (SRDs) Another system offering fall restraint and fall arrest protection is a self-retracting device (SRD). The SRD selected must be approved by the manufacturer for use with the MEWP. Some SRDs are not designed for use with anchorage points below the connection point on the protected worker. The manufacturer's specifications and instructions should be carefully followed. An SRD is shown in Figure 67.

FIGURE 67
MEWP fall protection SRD

Common MEWP Fall Accidents

A MEWP should provide workers with a stable and secure platform that will allow them to safely and efficiently complete tasks at height. However, MEWP accidents and injuries are not uncommon and many involve falls. Most falls from MEWPs can be traced to operator error or improper use of the equipment. Reasons for MEWP falls may include the following:

- Occupant is ejected or catapulted from a boom lift when it is struck by another vehicle or object or moves unexpectedly.
- Occupant climbs on guardrails or outside the platform.

- Occupant overreaches beyond the edge of the platform.
- Platform component failure occurs due to improper maintenance or inspection.

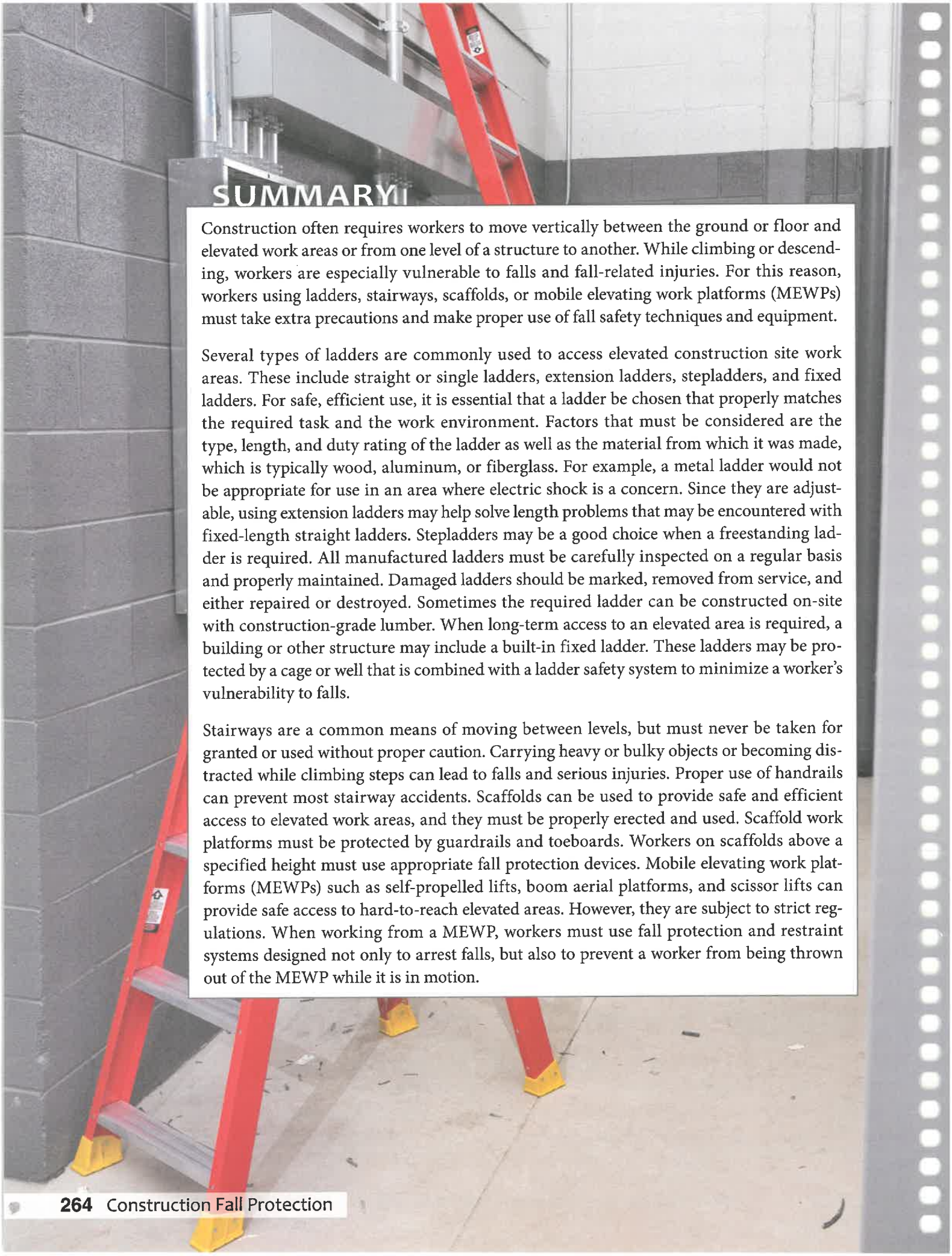
FALL AWARENESS SCENARIO

A maintenance technician was working from a mobile elevating work platform and leaned through the railing on the side of an upright I-beam to clear a jam and change a microswitch while the overhead crane system was active. The victim's back was turned toward the crane system as he worked. While the victim attempted to change the microswitch, the crane struck the victim's right hand as it was resting on top of the I-beam, causing him to fall 10′-0″ and land on the conveyor system below. A maintenance technician on the floor saw the victim fall and alerted in-house medical personnel. The first-response team assessed the victim's injuries while a call was placed for an ambulance. The ambulance arrived ten minutes later and transported the victim to the local hospital. However, the victim died in transit from multiple blunt force injuries and *mechanical asphyxia* sustained as a result of the fall.

- How could this incident have been prevented?
- Do you know anyone who has fallen from a work platform? How serious was the injury?

SELF CHECK

1. Describe a MEWP's fall restraint and fall arrest system that makes use of a lanyard with adjuster.
2. Describe a twin-legged lanyard and its purpose.
3. Describe four common MEWP accidents.



SUMMARY

Construction often requires workers to move vertically between the ground or floor and elevated work areas or from one level of a structure to another. While climbing or descending, workers are especially vulnerable to falls and fall-related injuries. For this reason, workers using ladders, stairways, scaffolds, or mobile elevating work platforms (MEWPs) must take extra precautions and make proper use of fall safety techniques and equipment.

Several types of ladders are commonly used to access elevated construction site work areas. These include straight or single ladders, extension ladders, stepladders, and fixed ladders. For safe, efficient use, it is essential that a ladder be chosen that properly matches the required task and the work environment. Factors that must be considered are the type, length, and duty rating of the ladder as well as the material from which it was made, which is typically wood, aluminum, or fiberglass. For example, a metal ladder would not be appropriate for use in an area where electric shock is a concern. Since they are adjustable, using extension ladders may help solve length problems that may be encountered with fixed-length straight ladders. Stepladders may be a good choice when a freestanding ladder is required. All manufactured ladders must be carefully inspected on a regular basis and properly maintained. Damaged ladders should be marked, removed from service, and either repaired or destroyed. Sometimes the required ladder can be constructed on-site with construction-grade lumber. When long-term access to an elevated area is required, a building or other structure may include a built-in fixed ladder. These ladders may be protected by a cage or well that is combined with a ladder safety system to minimize a worker's vulnerability to falls.

Stairways are a common means of moving between levels, but must never be taken for granted or used without proper caution. Carrying heavy or bulky objects or becoming distracted while climbing steps can lead to falls and serious injuries. Proper use of handrails can prevent most stairway accidents. Scaffolds can be used to provide safe and efficient access to elevated work areas, and they must be properly erected and used. Scaffold work platforms must be protected by guardrails and toeboards. Workers on scaffolds above a specified height must use appropriate fall protection devices. Mobile elevating work platforms (MEWPs) such as self-propelled lifts, boom aerial platforms, and scissor lifts can provide safe access to hard-to-reach elevated areas. However, they are subject to strict regulations. When working from a MEWP, workers must use fall protection and restraint systems designed not only to arrest falls, but also to prevent a worker from being thrown out of the MEWP while it is in motion.

Safe Use of Ladders, Stairways, Scaffolds, and Mobile Elevating Work Platforms

Show your understanding of the information in this chapter by answering the questions and filling in the blanks below.

1. When ascending or descending a ladder, always use _____-_____ contact.

2. Most ladders are made from wood, _____, aluminum, or a combination of these materials.

3. A(n) ____ is a self-supporting, portable ladder with flat steps and a hinged base and cannot be adjusted for length.
   a. extension ladder
   b. fixed ladder
   c. stepladder
   d. straight ladder

4. A(n) ____ is a non-self-supporting, portable ladder that cannot be adjusted for length and consists of one section of side members and steps or rungs.
   a. straight ladder
   b. fixed ladder
   c. stepladder
   d. extension ladder

5. A ____ angle is the appropriate and safest angle of a ladder set against a wall.
   a. 30°
   b. 50°
   c. 65°
   d. 75°

6. The maximum safe weight that can be placed on a Type IA (Extra Heavy Duty) ladder is ____.
   a. 250 lb
   b. 300 lb
   c. 350 lb
   d. 400 lb

7. Any ladders that have been exposed to corrosive substances, fire, or other sources of excessive heat must be carefully cleaned before returning them to service. (True; False)

8. A(n) ____ is a type of stepladder.
   a. platform ladder
   b. fixed ladder
   c. inverted ladder
   d. straight ladder

9. The only safe way to move a stepladder while it is in use is to descend, relocate the ladder, and then re-climb the ladder. (True; False)

10. When using a stepladder, the top two steps should never be stood on. (True; False)

11. When using a straight ladder or extension ladder on uneven surfaces, _____ _____ may be used to achieve equal rail support.

12. Safe extension ladder use requires maintaining a 6:1 vertical to horizontal ratio. (True; False)

13. Job-built ladders must be inspected for defect and damage by a(n) _____ _____ before each shift.

14. The width of a job-built ladder constructed at the jobsite should be _____.
    a. at least 12″, but not more than 1″
    b. at least 14″, but not more than 18″
    c. at least 16″, but not more than 20″
    d. at least 20″, but not more than 24″

15. A(n) _____ _____ is a vertical ladder that is mounted permanently to an existing structure.

16. A _____ is a fixed ladder enclosure fastened to the side rails of a fixed ladder or to the structure to encircle the climbing space and help prevent climbers from falling.
    a. cage
    b. pocket
    c. wrap-around
    d. well

17. A _____ is a permanent complete enclosure around a fixed ladder attached to the walls of the structure.
    a. cage
    b. pocket
    c. wrap-around
    d. well

18. _____ is an unsafe behavior on stairways because it blocks vision and makes it difficult to see where the feet are being placed.
    a. Talking on a cell phone
    b. Carrying a load at head height
    c. Running on the steps
    d. Carrying on a conversation

19. Temporary stairways never become a permanent part of a building or structure. (True; False)

20. A(n) _____ _____ is a barrier erected along the exposed or open side of stairways to prevent workers from falling to a lower level.

21. Temporary handrails must have a minimum clearance ____ between the handrail and wall, stair rail system, or other objects.

a. 1″
b. 2″
c. 3″
d. 5″

22. Most scaffolds higher than ____ offer both passive and active fall protection systems.

a. 3′-0″
b. 6′-0″
c. 9′-0″
d. 10′-0″

23. A mobile elevating work platform (MEWP) is a mobile device that includes a(n) _____ platform and is supported from ground level by a vehicle or self-supporting platform.

24. A MEWP's guardrails or guardrail system can be used as a lanyard anchorage point. (True; False)

25. Most falls from MEWPs can be traced to _____ _____ or _____ _____ of the equipment.

WORKSHEET 1

Ladder Safety

Instructions Watch the videos provided by the instructor and take notes. When prompted by the instructor, join in a class discussion on ladder safety.

1. Ladder Safety Video 1: Notes

2. Ladder Safety Video 2: Notes

Ladder Inspection

Instructions Using the ladders supplied by the instructor, perform a complete inspection and complete the Ladder Inspection Form below. Be sure to indicate any damage that may be found and the corrective actions that should be taken.

Ladder Inspection Form

Company Name: _____

Manufacturer: _____ Model # _____

Inspector: _____ Dept. _____

☐ STEPLADDER

Size:_____ ft.

☐ Fiberglass
☐ Aluminum
☐ Wood

Circle areas of damage

	YES	NO
Steps: Loose, cracked, bent, or missing	☐	☐
Rails: Cracked, bent, split, or frayed rail shields	☐	☐
Labels: Missing or not readable	☐	☐
Pail Shelf: Loose, bent, missing, or broken	☐	☐
Top: Cracked, loose, or missing	☐	☐
Spreader: Loose, bent, or broken	☐	☐
General: Rust, corrosion, or loose	☐	☐
Other: Bracing, shoes, or rivets	☐	☐

ACTIONS:

☐ Ladder tagged as damaged and removed from use

☐ Ladder is in good condition

☐ PODIUM

Size:_____ ft.

☐ Fiberglass
☐ Aluminum
☐ Wood

Circle areas of damage

	YES	NO
Steps: Loose, cracked, bent, or missing	☐	☐
Rails: Cracked, bent, split, or frayed rail shields	☐	☐
Labels: Missing or not readable	☐	☐
Top: Cracked, loose, or missing	☐	☐
Spreader: Loose, bent, or broken	☐	☐
Platform: Cracked or bent	☐	☐
General: Rust, corrosion, or loose	☐	☐
Other: Bracing, shoes, or rivets	☐	☐

ACTIONS:

☐ Ladder tagged as damaged and removed from use

☐ Ladder is in good condition

☐ EXTENSION LADDER

Size:_____ ft.

☐ Fiberglass
☐ Aluminum

Circle areas of damage

	YES	NO
Steps: Loose, cracked, bent, or missing	☐	☐
Rails: Cracked, bent, split, or frayed	☐	☐
Labels: Missing or not readable	☐	☐
Rung Locks: Loose, bent, missing, or broken	☐	☐
Hardware: Damaged, loose, or missing	☐	☐
Shoes: Worn, broken, or missing	☐	☐
Rope / Pulley: Loose, bent, or broken	☐	☐
General: Rust, corrosion, or loose	☐	☐
Other: Bracing rivets	☐	☐

ACTIONS:

☐ Ladder tagged as damaged and removed from use

☐ Ladder is in good condition