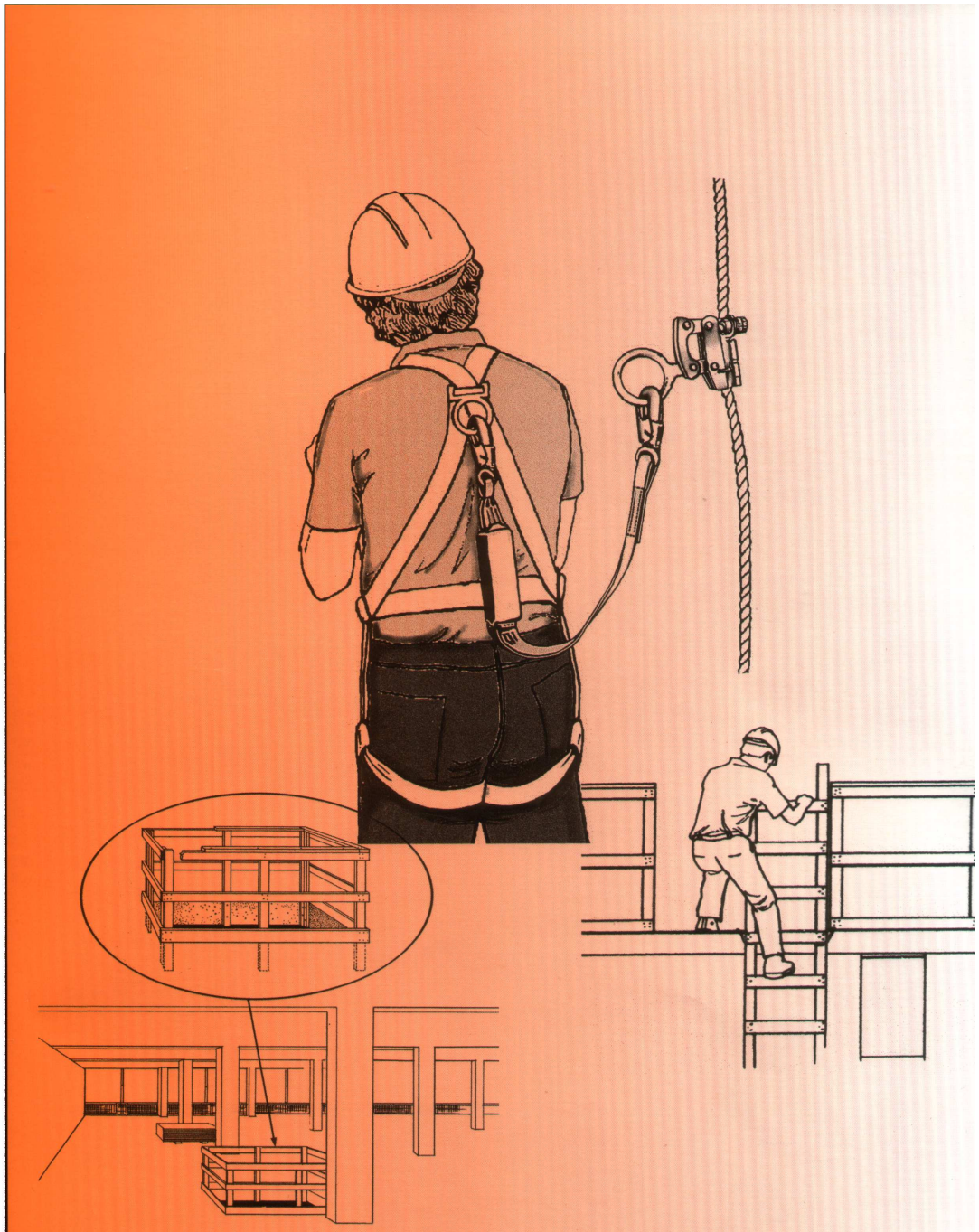
CONSTRUCTION
SAFETY



BASICS OF FALL PROTECTION

User's Guide

INTRODUCTION

Over the last 20 years, falls have accounted for the single largest number of serious construction injuries and accidental deaths. Most of these deaths and injuries occurred because fall protection was either missing or not used.

Wherever fall protection is in place, and used correctly, it works. The more you know about fall protection in construction the safer you'll be. Your life depends on it.

This ***User's Guide*** is part of a training program. The training goal is to provide the basic knowledge required for construction personnel to work safely in areas exposed to fall hazards. The objectives are to enable users to

- recognize fall hazards
- identify and apply fall protection controls, including fall prevention and fall arrest.

LEGAL RESPONSIBILITIES

The following requirements are spelled out in Ontario's *Occupational Health and Safety Act*.

Employers

Employers are responsible for taking every precaution reasonable to protect workers. This can include

- creating and enforcing safe work procedures and policies
- ensuring that any required equipment, materials, or safety devices are available, properly maintained, and used according to manufacturers' or designers' instructions.

Employers must also provide competent people to supervise workers. Supervisors must be able to recognize hazards on site and implement appropriate measures to eliminate or control those hazards.

Where a worker has to use specialized safety equipment or follow specific safe work procedures, the employer must provide adequate training in a language the worker understands. This applies to fall protection.

Supervisors

Supervisors are responsible for taking every precaution reasonable to protect workers. Supervisors must advise workers of any existing or potential hazards and ensure that each worker works in a safe manner.

Where particular materials, equipment, protective devices, or safe work practices are required, supervisors must ensure that affected workers comply with requirements and use materials and equipment properly.

Supervisors must also provide proper and adequate instructions to workers regarding safety-related equipment and materials as well as specific procedures to be followed.

Workers

Workers must use all equipment and protective devices—and follow all safe work policies and procedures—required by employers.

In addition workers must report to supervisors any hazard and any defect in safety-related equipment or material workers become aware of.

Remember—workers have the right to refuse to work, or do any portion of a given task, if they believe that a hazard is likely to endanger themselves or another worker or that adequate protection against the hazard has not been provided. This includes the hazard of falling. See Appendix 1 in this guide.

Fines and Penalties

Violations of the *Occupational Health and Safety Act* and of regulations made under the Act are punishable by fines and penalties.

The penalty for an individual—including employer, supervisor, or worker—convicted of failing to comply with the Act, regulations, or Ministry of Labour orders is a maximum fine of $25,000 or imprisonment up to twelve months or both. The penalty for a corporation is a maximum fine of $500,000 for each offence.

Fall Protection Training

Effective 12 June 2002, the construction regulation (Ontario Regulation 213/91) requires

- that employers ensure that workers using a fall protection system are trained in its use
- that training records are kept, including training dates and participants' names
- that employers make training records available to Ministry of Labour inspectors on request.

These and other requirements for fall protection are specified in Section 26 of the regulation (see Appendix 2 in this guide).

BASIC HAZARDS and CONTROLS

Some form of fall protection must be used wherever workers are exposed to the hazard of falling

1) more than 3 metres (10 feet)
2) more than 1.2 metres (4 feet) if the work area is used as a path for a wheelbarrow or similar equipment
3) into operating machinery
4) into water or another liquid
5) into a hazardous substance or object
6) through an opening in a work surface.

The best means of fall protection is a guardrail system complying with the current construction regulation (O. Reg. 213/91).

Where it isn't possible to install guardrails, workers must be protected by at least one of the following fall protection methods:

- fall prevention
- fall arrest.

Fall prevention includes

- proper use of worksite access such as ladders and scaffolds
- protective covers over floor and roof openings
- warning barriers and bump lines
- guardrail systems
- travel restraint.

Fall arrest includes

- fall restriction
- fall arrest
- safety nets.

Regardless of type, every fall protection system in Ontario construction must meet the requirements of the *Occupational Health and Safety Act*, the construction regulation (O.Reg. 213/91), and any applicable National Standards of Canada standards.

FALL PREVENTION

The best protection is to prevent falls from happening in the first place. Fall prevention uses physical means to keep workers away from situations where they might fall. The following sections outline fall prevention related to ladders, scaffolds, powered elevating work platforms, protective covers, warning barriers, bump lines, guardrails, and travel-restraint systems.

Ladders - General

Falls from ladders are one of the most serious problems in construction. Falls occur for the following reasons:

- Ladders are not held, tied off, or otherwise secured before being used.
- Rain, snow, ice, mud, or other slippery substances on rungs or at ladder base and top cause workers to lose footing.
- Users fail to maintain three-point contact (one hand and two feet or two hands and one foot) when climbing up and down or working from the ladder.

- Users fail to keep their centre of gravity between the side rails and reach or lean out too far.
- Users don't face the ladder when climbing up or down.
- Ladders are set up on poor footing.
- Ladders are set up at angles too steep or too low, causing them to tip or slide.
- Ladder components such as rungs and hooks are damaged or defective.
- High winds topple ladders or knock users off.
- Areas at the base and top of ladders are not clear of obstructions, slippery substances, and other hazards.

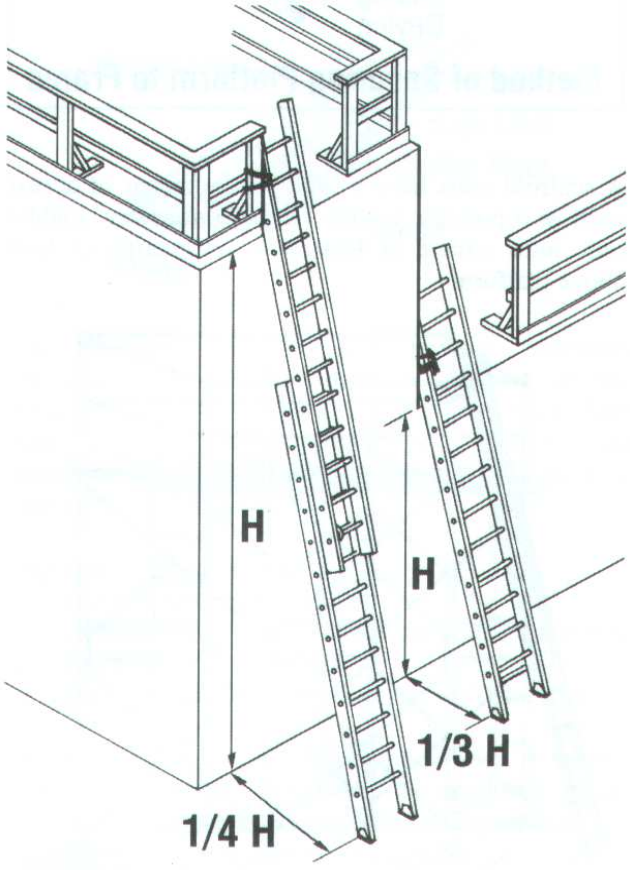
When any ladder must be set up next to an unprotected edge where a fall of 3 metres (10 feet) or more could occur, workers using the ladder must be protected by a fall-arrest system.

Portable Ladders

These are the most commonly used ladders in construction. They may be manufactured from wood, aluminum, or fibreglass, or be constructed on site.

Minimum requirements

- ✓ Designed, constructed, and maintained to support all loads reasonably expected for a given job
- ✓ Free from loose, damaged, or defective rungs
- ✓ Rungs spaced at 300 millimetres (1 foot) on centres
- ✓ Side rails at least 300 millimetres (1 foot) apart
- ✓ Set up a safe distance from live electrical conductors and equipment
- ✓ Set up on firm, level footing or, if ground is soft or muddy, on a mud sill
- ✓ Erected one metre out for every three or four metres up.



Proper Ladder Angles

Portable ladders used for regular access between levels must

- ✓ extend at least 900 millimetres (3 feet) above upper landing
- ✓ have a clear space of at least 150 millimetres (6 inches) behind each rung
- ✓ have a landing surface at top and bottom adequate and free of obstructions, debris, and other hazards
- ✓ be firmly secured at top and bottom to prevent movement.

Where a portable ladder must bear against a vertical surface and there's no means to tie the top off, a ladder stabilizer can provide additional stability. Stabilizers are manufactured to suit various applications.

Inspection Checklist

- ☐ Side rails not twisted, cracked, dented, or otherwise damaged
- ☐ Rungs straight and free of cracks, significant wearing, and distortion
- ☐ Feet on side rails intact and operating as originally manufactured
- ☐ Wooden ladders free of paint or other opaque coatings that may conceal defects such as cracks
- ☐ No slipshod repairs or makeshift replacements
- ☐ Damaged or defective ladders tagged and immediately removed from service
- ☐ Repairs done only by manufacturer or competent worker.

Stepladders

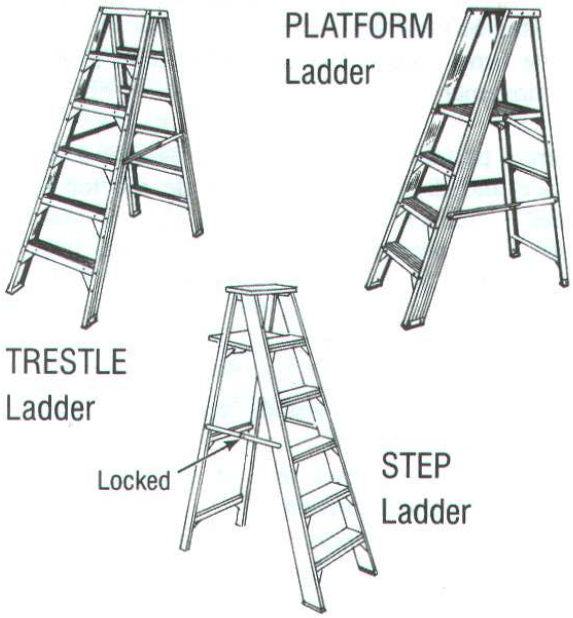
There are two basic requirements:

1) Make sure legs are fully open and spreaders pushed down and locked.
2) Never stand on the top step or the pail shelf.

Other safeguards include the following.

- Make sure that hinges between the two halves of the ladder and connection points on the spreaders are in good condition and operate as originally manufactured with no lateral play in the joints.
- Check that spreaders are not deformed, damaged, or otherwise defective.
- Always set up the ladder on a secure, firm, flat surface. Never set up a ladder on piled material or debris.
- Use the ladder only in the fully open position, not as a straight ladder propped or leaning against a structure.
- Before setting up a stepladder, check for overhead electrical hazards.
- Keep your centre of gravity between the side rails of the ladder to avoid tipping.

- Always use a stepladder that is the correct height for the job so that the work can be done without having to stand on the upper steps.
- Never use stepladders for temporary bracing or shoring—they're not designed for that kind of loading.



Step Ladders

Fixed Ladders

These include steel ladders permanently attached to buildings and other structures. Fixed vertical access ladders are primarily used for maintenance and repair operations.

Before using any vertical access ladder fixed to the side of a building, make sure that
- wall anchors are in good condition
- anchors aren't loose or pulling out of the wall
- there's no excessive rust between rungs and side rails, between side rails and wall brackets, or between brackets and anchors
- a ladder higher than 3 metres (10 feet) above grade is equipped with a safety cage or other means of fall protection.

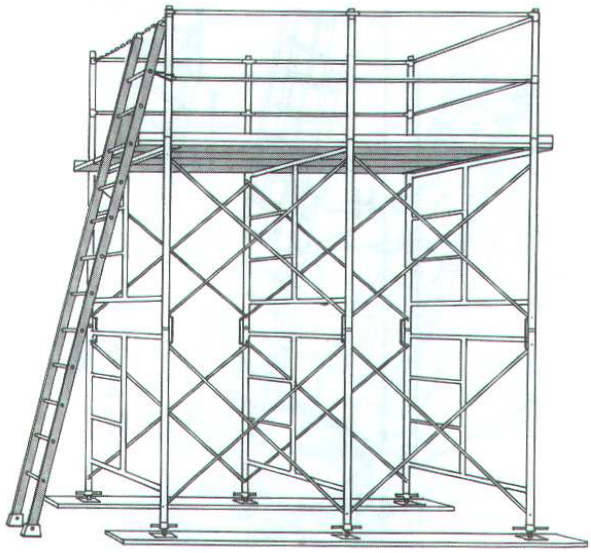
Scaffolds

Falls from scaffolds occur in connection with
- erecting and dismantling
- climbing up and down
- platforms not fully planked
- planks sliding off or breaking
- lack of guardrails
- failure to install all required components such as base plates, braces, and clips
- using damaged components such as bent frames or braces
- moving rolling scaffolds with workers on the platform who are not properly tied off to a fixed support.

A scaffold work platform
- must be at least 460 millimetres (18 inches) wide
- must consist of planks laid tightly side by side over the full width of the platform if the platform is more than 2.4 metres (8 feet) high
- must be provided with guardrails meeting requirements of the current construction regulation if the platform is more than 2.4 metres (8 feet) high
- must not have any unguarded or unprotected openings
- must have each platform component secured to prevent slippage.

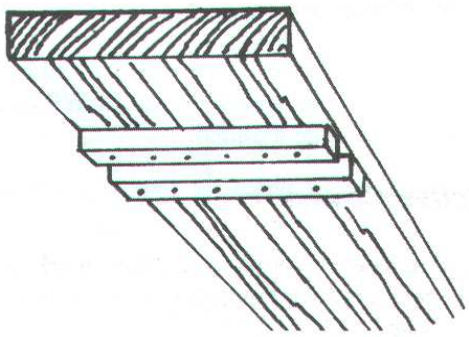
Method of Securing Platform to Frame

A scaffold must have a safe, secure means of access such as a portable ladder, ramp, or stairway. Ladder rails must extend at least 900 millimetres (3 feet) above platform.



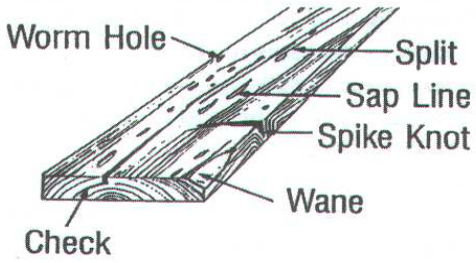
Scaffold planks
- must be at least 48 mm by 248 mm (2" x 10")
- must meet or exceed requirements for Number 1

Grade SPF (spruce-pine-fir)—select structural grades of SPF or Douglas fir are strongly recommended
- must overhand their supports by no less than 150 millimetres (6 inches) and no more than 300 millimetres (12 inches)
- must have cleats at one end to fit over the scaffold frame and prevent the planks from sliding off.



Plank cleated to prevent sliding

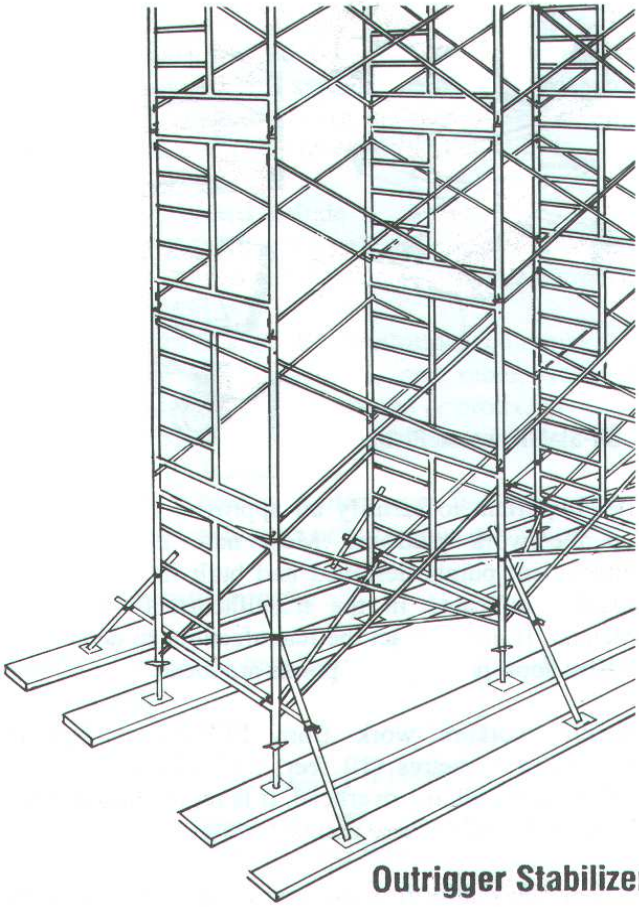
Scaffold planks must also be inspected regularly and must be discarded if damaged or deteriorated. Look for the following defects:



To maintain stability and prevent sideways movement, the scaffold must be secured to the structure at vertical intervals not greater than three times the least lateral dimension of the scaffold measured at the base. Installing outriggers at the base can increase this dimension.

Outriggers are used to
- provide additional stability
- increase the height at which the scaffold needs to be tied into the structure
- provide stability where tying-in isn't possible.

Workers erecting or dismantling scaffolds at heights over 2.4 metres (8 feet) must be protected by an appropriate fall protection or fall-arrest system.



Outrigger Stabilizers

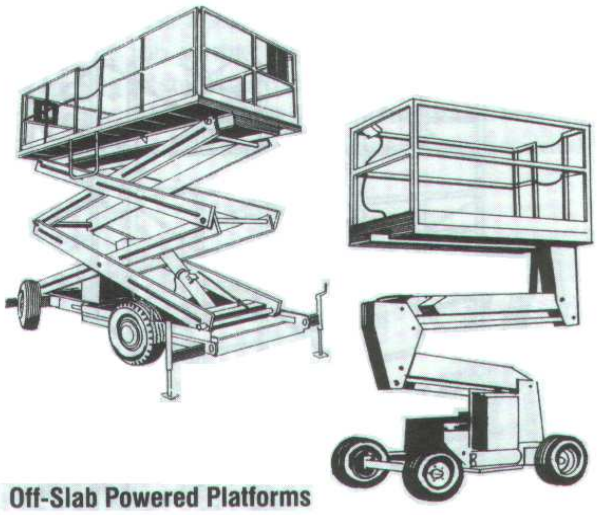
Casters or wheels on rolling scaffolds must be equipped with brakes that can be applied before any worker mounts, uses, or dismounts from the scaffold.

Rolling scaffolds with pneumatic tires must never be supported on the tires while being erected, used, or dismantled.

If it's necessary to move a rolling scaffold with workers aboard, the workers must adequately tie off to a fixed support.

Powered Elevating Work Platforms

Fall protection for powered elevating work platforms (PEWPs) includes the following minimum requirements:
- the PEWP must be equipped with guardrails and
- the PEWP must not be moved with workers aboard unless each worker wears a full body harness adequately tied off to the platform.



Off-Slab Powered Platforms

It's important to identify all approved tie-off points on the work platform. Most new PEWPs have attachment points designed and built in. These are usually indicated in the manufacturers' operating manual. If not, contact the manufacturer to determine where appropriate tie-off points are located.

Where workers work from PEWPs at heights exceeding 3 metres (10 feet) and adequate anchor points are available overhead, it is recommended that workers tie off to these points.

Before the platform is lowered or moved to another location, the workers must first unhook from the overhead points and then tie off to the platform.

Whenever possible, lower the work platform before moving. This keeps the centre of gravity as close to the wheels as possible, thereby reducing the risk of tipping.

- Always operate PEWPs on a firm level surface.
- Before using the equipment, inspect the work area for overhead powerlines and other electrical hazards.
- Also inspect the work area for hazards such as grade changes, curbs, or drop-offs.

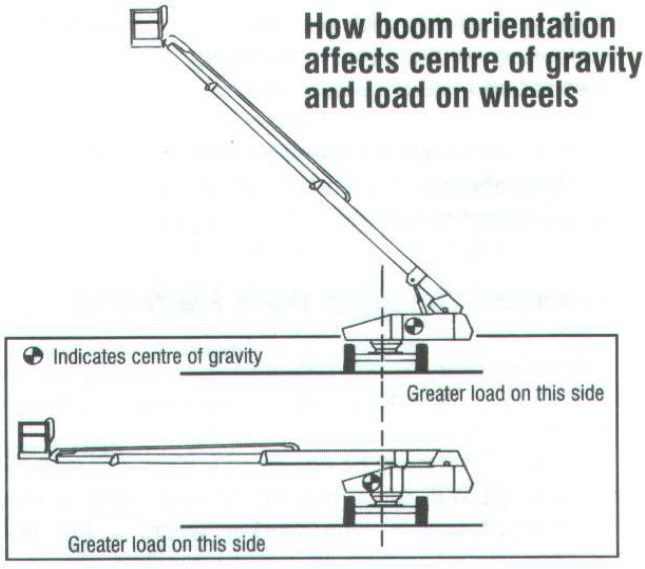
Ensure that covers over openings are either strong enough to support the weight of the PEWP or clearly marked so they can be avoided.

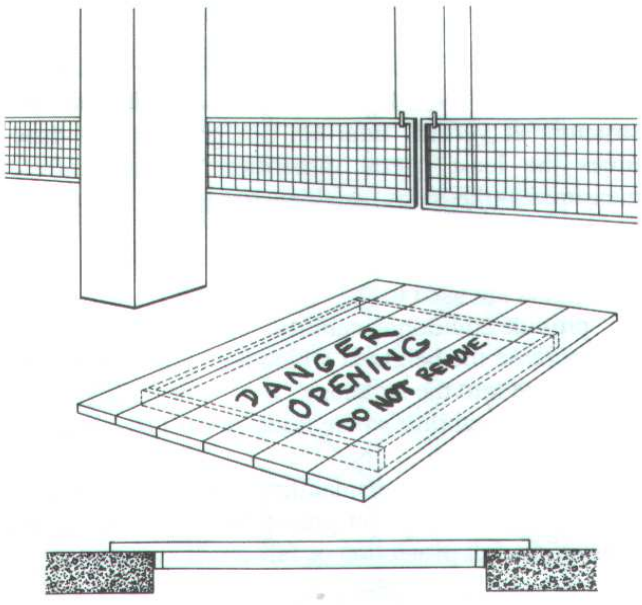
Protective Covers

Openings in floors, roofs, and other work surfaces must be protected by guardrails or covers if the openings pose a fall hazard.

Protective covers must

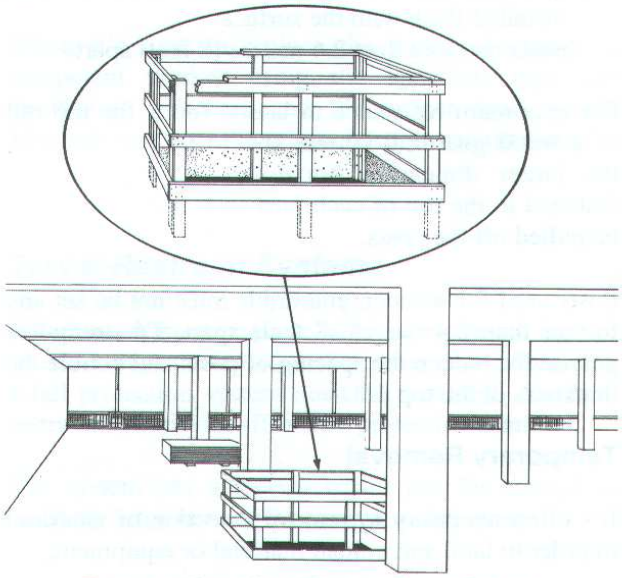
- completely cover the opening
- be securely fastened together as well as to the sides of the opening
- be clearly identified as a cover
- be constructed of material adequate to support all expected loads
- be capable of supporting a live load of at least 2.4 kilopascals (50 pounds per square foot) without exceeding the allowable unit stress for the material used.





Pallet-Style Cover

A guardrail can also be used as protection around openings in floors and roofs.



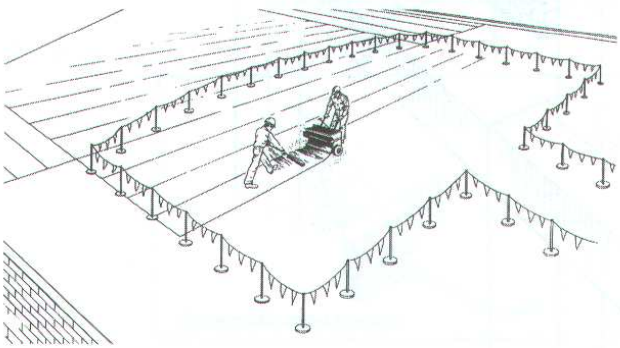
Protection for Floor Openings

Warning Barriers and Bump Lines

Warning barriers and bump lines prevent falls by alerting workers to fall hazards. Warning barriers and bump lines should be set up around the work area at least 2 metres (6 feet 6 inches) from unprotected edges.

When a work area is enclosed by properly installed and maintained warning barriers or bump lines, work inside the area can be done without additional fall protection measures. But anyone outside the area who is working less than 2 metres from the edge must be provided with a fall protection or fall-arrest system.

Lines or barriers should be 1.07 metres (42 inches) high and consist of weighted posts, fibre rope, and warning flags or signs along their entire length.



Guardrails

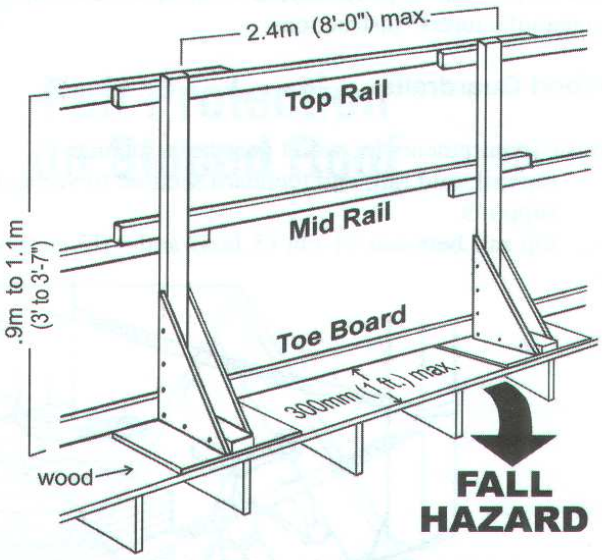
A worker at risk of falling more than 3 metres (10 feet) must be protected by a safety net, fall-arrest system, travel-restraint system, or guardrail system. In most cases, guardrails are the most common and convenient means of fall protection.

Areas to be protected include

- open edges of floors, mezzanines, and balconies (it's not enough simply to barricade the entrance to a balcony)
- open edges of scaffolds, platforms, and ramps
- openings in floors, roofs, and other working surfaces not otherwise covered or protected
- edges of slab formwork for floors and roofs
- edges of bridge surfaces
- locations where a worker may fall into water, operating machinery, or hazardous substances.

General Requirements

Guardrails must be installed no farther than 300 mm from an edge.

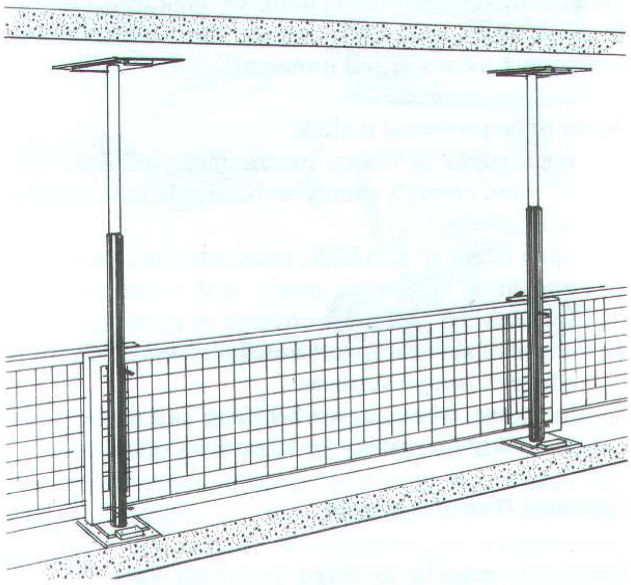


Typical Dimensions for Guardrails

A guardrail must be capable of resisting—anywhere along its length and without exceeding the allowable unit stress for each material used—the following loads when applied separately:

- a point load of 675 newtons (150 pounds) applied laterally to the top rail
- a point load of 450 newtons (100 pounds) applied in a vertical downward direction to the top rail
- a point load of 450 newtons (100 pounds) applied in a lateral or vertical downward direction to the mid-rail
- a point load of 225 newtons (50 pounds) applied laterally to the toeboard.

Shoring jacks used as guardrail posts should be fitted with plywood softener plates top and bottom. Snug up and check the posts regularly for tightness.



Guardrail systems using "farm gate" fencing panels and spring-loaded posts should be installed according to manufacturers' instructions.

Wood Guardrails

Basic requirements for wood guardrails include

- top rail, mid rail, and toeboard secured to vertical supports
- top rail between 91 cm (3 feet) and 1.07 metres (3 feet 6 inches) high
- toeboard at least 10.2 cm (4 inches) high—89 mm (3½ inches) high if made of wood—and installed flush with the surface
- posts no more than 2.4 metres (8 feet) apart.

For maximum resistance to lateral force, the top rail of a wood guardrail system should be laid flat with the larger dimension horizontal and be securely fastened to the top of each post so that the rails can't be pulled off the posts.

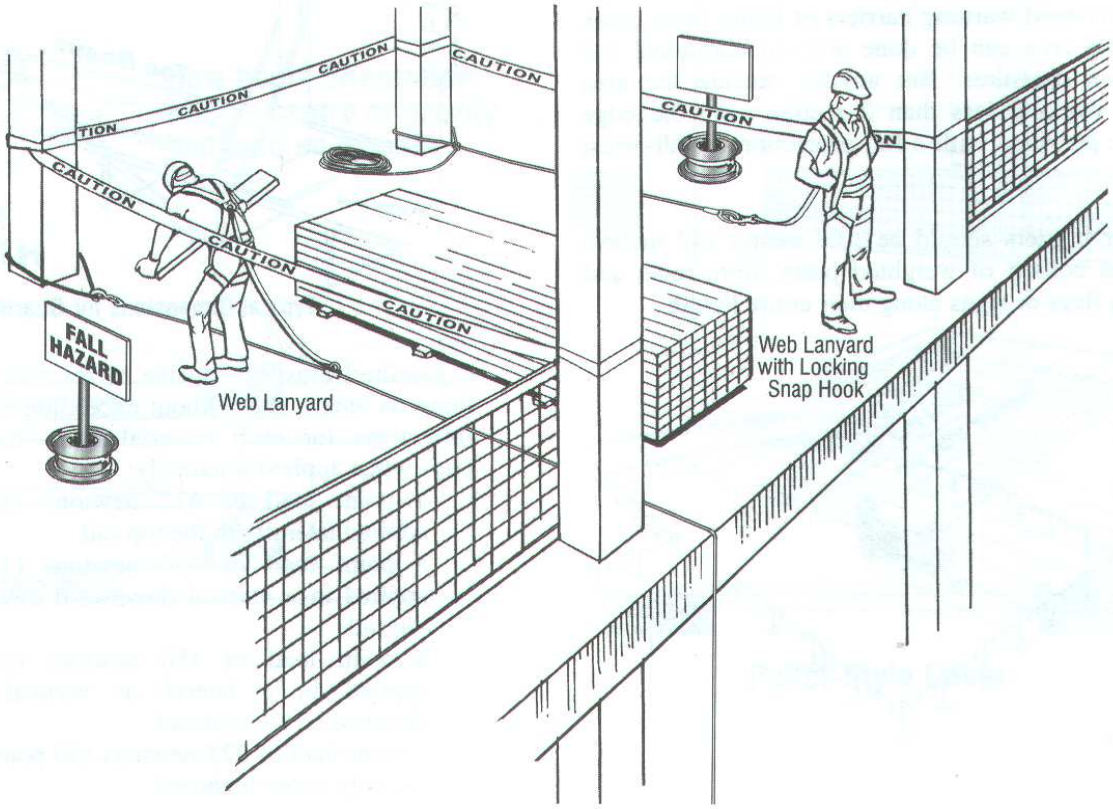
Posts used for wooden guardrails must not be set any further than 2.4 metres (8 feet) apart. To strengthen guardrails, reduce the spacing of posts and double the thickness of the top rail.

Temporary Removal

It's often necessary to remove a section of guardrail in order to land and unload material or equipment.

Before removing the guardrail, workers in the area must tie off using a travel-restraint or fall-arrest system.

The area should be cordoned off with caution tape or a bump line at least 2 metres (6 feet, 6 inches) from either side of the opening and from the edge of the work surface. Warning signs should also be posted.



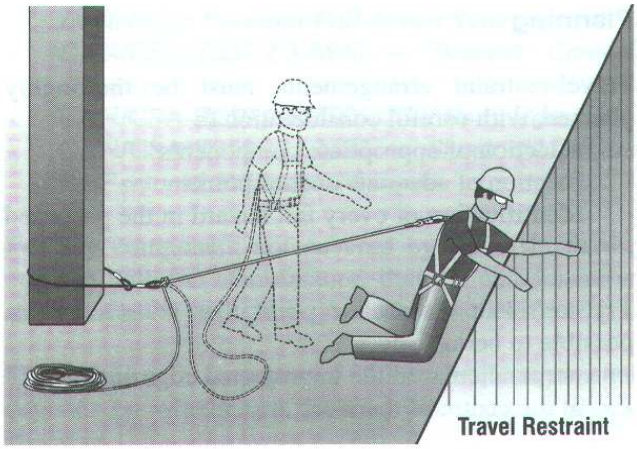
Guardrail posts temporarily removed should be unfastened from the deck using proper tools, not pried or pulled off, and placed safely out of the way.

When it's time to replace the guardrail section, a competent worker using the specified type and number of fasteners and the proper tools should install posts as per the original design requirements.

Travel-Restraint Systems

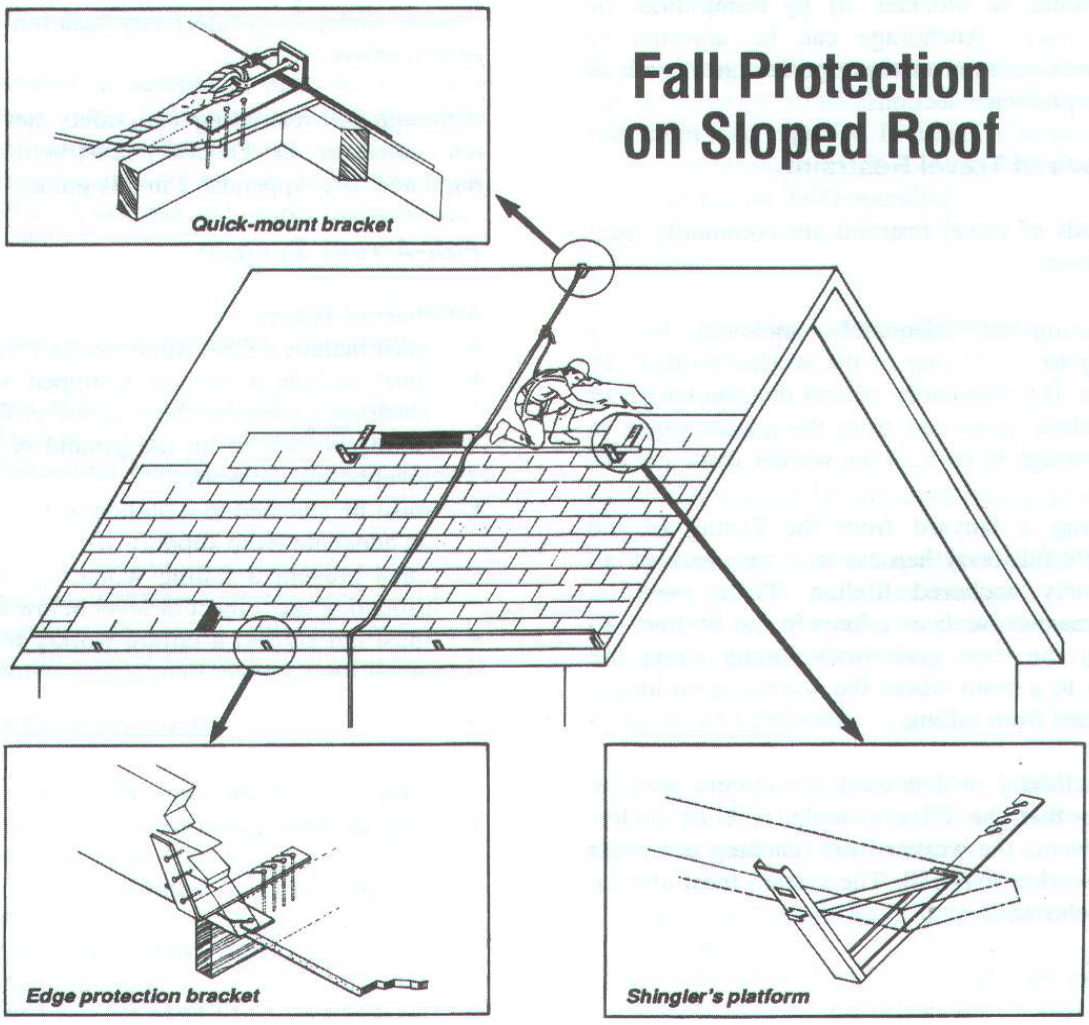
Where work must be done within 2 metres (6 feet) of an open, unprotected edge that presents a fall hazard, a fall protection system must be provided. A travel-restraint system can afford the protection required.

The system lets a worker travel just far enough to reach the edge but not far enough to fall over.



The basic travel-restraint system consists of

- CSA-approved full body harness
- lanyard
- lifeline
- rope grab to attach harness or lanyard to lifeline
- adequate anchorage (capable of supporting a static load of 2 kilonewtons—450 pounds—with a recommended safety factor of at least 2, that is, 4 kilonewtons or 900 pounds).



Planning

Travel-restraint arrangements must be thoroughly planned, with careful consideration to
- selection of appropriate components
- location of adequate anchor points
- identification of every fall hazard in the proposed work area.

Try to select an anchor point that is as close as possible to being
- perpendicular to the unprotected edge and
- at the centre of the work area.

All fall hazards in the work area must be identified. Pay special attention to work areas with irregular shaped perimeters, floor openings, or locations near corners.

A fully extended lifeline and/or lanyard that adequately restrains a worker from a fall hazard in one section of the work area may be too long to provide the same protection in other adjacent sections of the work area.

Points where the system cannot provide travel restraint should be blocked off by bump lines or warning barriers. Anchorage can be adjusted to provide travel restraint at these points once work is complete in protected sections.

Basic Types of Travel Restraint

Two methods of travel restraint are commonly used in construction.

1) Connecting an adequately anchored lifeline directly to the D-ring of the worker's full body harness. It's absolutely critical that the length of the lifeline, measured from the anchor point, is short enough to restrain the worker from any fall hazard.
2) Attaching a lanyard from the D-ring of the worker's full body harness to a rope grab on an adequately anchored lifeline. There must be some means—such as a knot in the lifeline—to prevent the rope grab from sliding along the lifeline to a point where the worker is no longer restrained from falling.

Whether method 1 or 2 is used, the system must be adjusted so that the fully extended lifeline and/or lanyard prevents the worker from reaching any point where the worker may fall. The system must also be securely anchored.

FALL ARREST

Where workers cannot be protected from falls by guardrails or travel restraint, they must be protected by at least one of the following methods:
- fall-restricting system
- safety net
- fall-arrest system.

In the event of a fall, these systems must keep a worker from hitting the ground, the next level below, or any other objects below.

Requirements for design, installation, inspection, and use of each system are defined in the construction regulation (see Appendix 2 in this guide).

Fall-Restricting and Safety Net Systems

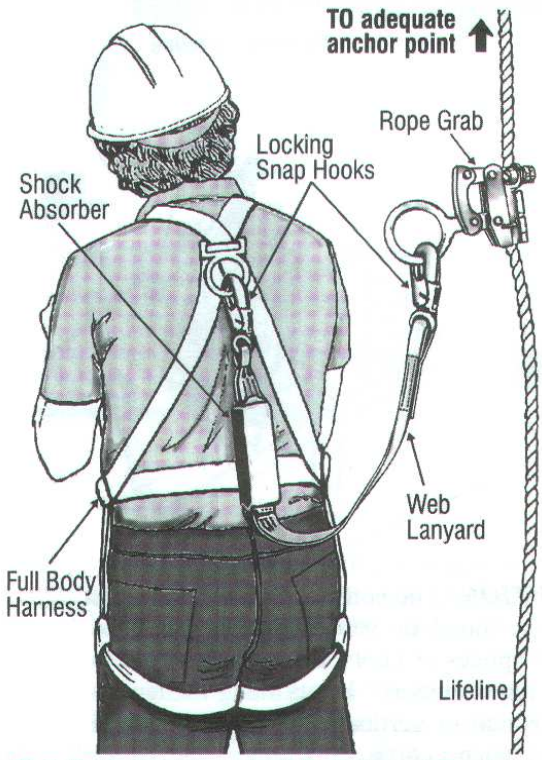
A fall-restricting system is designed to limit a worker's free fall distance to 0.6 metres (2 feet). One type uses a belt grab or belly hook that attaches to a safety rail on a fixed ladder.

A safety net system must be designed by a professional engineer. The system is installed below a work surface to protect any location where a fall hazard exists.

Although fall-restricting and safety net systems are not common in Ontario construction, both are regulated (see Appendix 2 in this guide).

Fall-Arrest System

A fall-arrest system
- must include a CSA-approved full body harness
- must include a lanyard equipped with a shock absorber unless the shock absorber could cause a falling worker to hit the ground or an object or level below the work
- must be attached to a lifeline or by the lanyard to an adequate fixed support
- must prevent a falling worker from hitting the ground or any object or level below the work
- must not subject a falling worker to a peak fall-arrest force greater than 8 kilonewtons.



Full Body Harness and Fall Arrest System

The construction regulation (O.Reg. 213/91) requires that

- all fall protection equipment must be inspected for damage, wear, and obvious defects by a competent worker before each use
- any worker required to use fall protection must be trained in its safe use and proper maintenance.

Any defective component should be replaced by one that meets or exceeds the manufacturer's minimum performance standards for that particular system.

The regulation also requires that any fall-arrest system involved in a fall be removed from service until the manufacturer certifies all components safe for reuse.

For any worker receiving instruction in fall protection, the manufacturer's instructions for each piece of equipment should be carefully reviewed, with particular attention to warnings and limitations.

Fall-Arrest Components

The Canadian Standards Association (CSA) provides minimum standards for most components of personal fall protection equipment:

- CAN/CSA-Z259.1-M99 – *Safety Belts and Lanyards*
- CAN/CSA-Z259.2.1-M98 – *Fall-Arrest Devices and Vertical Lifelines*
- CAN/CSA-Z259.2.2-M98 – *Self-Retracting Devices for Personal Fall-Arrest Systems*
- CAN/CSA-Z259.2.3-M98 – *Descent Control Devices*
- CAN/CSA-Z259.10-M90 – *Full Body Harnesses*
- CAN/CSA-Z259.111-M92 – *Shock Absorbers for Personal Fall-Arrest Systems.*

For any component not covered by these standards, confirm with the manufacturer that the component is suitable for the particular system being considered.

The minimum strength of fall-arrest components depends on whether or not the system uses a shock absorber.

- In systems *without* shock absorbers, all components, including lifeline and lifeline anchorage, must be able to support a static load of at least 8 kilonewtons (1800 pounds) without exceeding the allowable unit stress of the materials used for each component.
- In systems *with* shock absorbers, all components, including lifeline and lifeline anchorage, must be able to support a static load of 6 kilonewtons (1350 pounds) without exceeding the allowable unit stress of the materials used for each component.

In designing both systems, it is recommended that a safety factor of at least two be applied to the stated minimum load capacity. In practical terms, anchorage should be strong enough to support the weight of a small car (about 3600 pounds).

Lifelines

There are three basic types of lifelines:

1) vertical
2) horizontal
3) retractable.

All lifelines must be inspected daily to ensure that they are

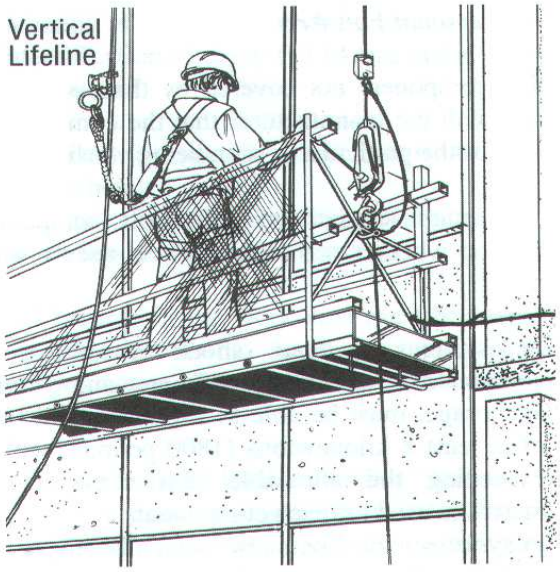
- free of cuts, burns, frayed strands, abrasions, and other defects or signs of damage
- free of discolouration and brittleness indicating heat or chemical exposure

1) Vertical Lifelines

Vertical lifelines must comply with the current edition of the applicable CSA standard and the following minimum requirements:

- Only one person at a time may use a vertical lifeline.
- A vertical lifeline must reach the ground or a level above ground where the worker can safely exit.

- A vertical lifeline must have a positive stop to prevent the rope grab from running off the end of the lifeline.



Vertical lifelines are typically 16-millimetre (5/8-inch) synthetic rope (polypropylene blends).

2) Horizontal Lifelines

The following requirements apply to any horizontal lifeline system:

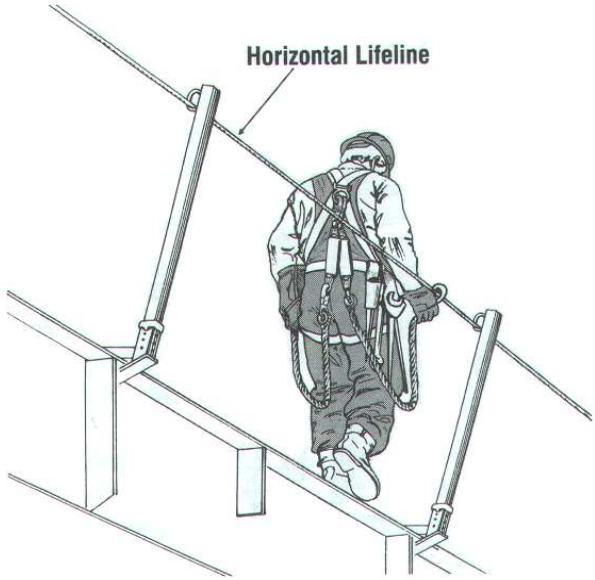
- The system must be designed by a professional engineer according to good engineering practice.
- The design can be a standard design or specifically engineered for the site.

The design for a horizontal lifeline system must

- ✓ clearly indicate how the system is to be arranged, including how and where it is to be anchored
- ✓ list and specify all required components
- ✓ clearly state the number of workers that can safely be attached to the lifeline at one time
- ✓ spell out instructions for installation, inspection, and maintenance
- ✓ specify all of the design loads used to design the system.

The system must be installed, inspected, and maintained in accordance with the professional engineer's design.

Before each use, the system must be inspected by a professional engineer or competent worker designated by a supervisor. A complete and current copy of the design must be kept on site as long as the system is in use.



CAUTION: The construction regulation requires that "a horizontal or vertical lifeline shall be kept free from splices or knots, except knots used to connect it to a fixed support." Knots along the length of either a horizontal or vertical lifeline can reduce its strength by as much as 40%.

3) Retractable Lifelines

Retractable lifelines consist of a lifeline spooled on a retracting device attached to adequate anchorage.

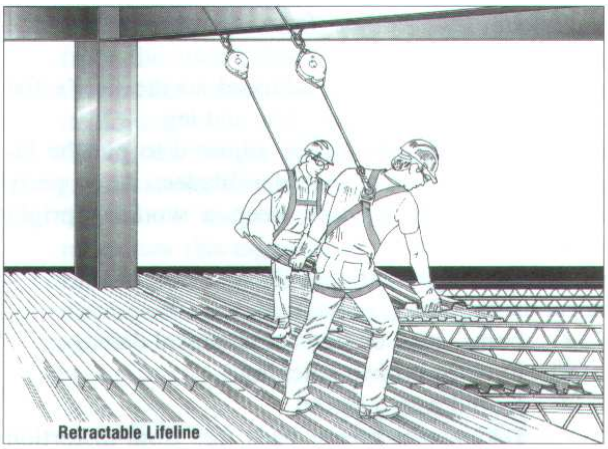
Retractable lifelines must comply with CAN/CSA-Z259.2.2-M98.

In general, retractable lifelines

- are usually designed to be anchored above the worker
- employ a locking mechanism that lets line unwind off the drum under the slight tension caused by a user's normal movements
- automatically retract when tension is removed, thereby preventing slack in the line
- lock up when a quick movement, such as that caused by a fall, is applied
- are designed to minimize fall distance and the forces exerted on a worker's body by fall arrest.

Always refer to the manufacturer's instructions regarding use, including whether a shock absorber is recommended with the system.

Any retractable lifeline involved in a fall arrest must be removed from service until the manufacturer or a qualified testing company has certified it for reuse.



Lifeline Hazards

Ultraviolet light – Exposure to the sun may damage or weaken synthetic lifelines. Ensure that material being considered for lifelines is UV-resistant.

Temperature – Extreme heat can weaken or damage some lifelines while extreme cold can make others brittle. Ensure that material being considered for lifelines can stand up to the most extreme conditions expected.

Friction and abrasion – Normal movement may wear, abrade, or otherwise damage lifelines in contact with sharp or rough surfaces. Protection such as wood softeners or rubber mats can be used at contact points to prevent wear and tear.

Sparks or flame – Hot work such as welding or flame cutting can burn, melt, cut, or otherwise damage a lifeline. Ensure that material being considered for lifelines is flame-resistant or provide appropriate protection where sparks or flame may be encountered.

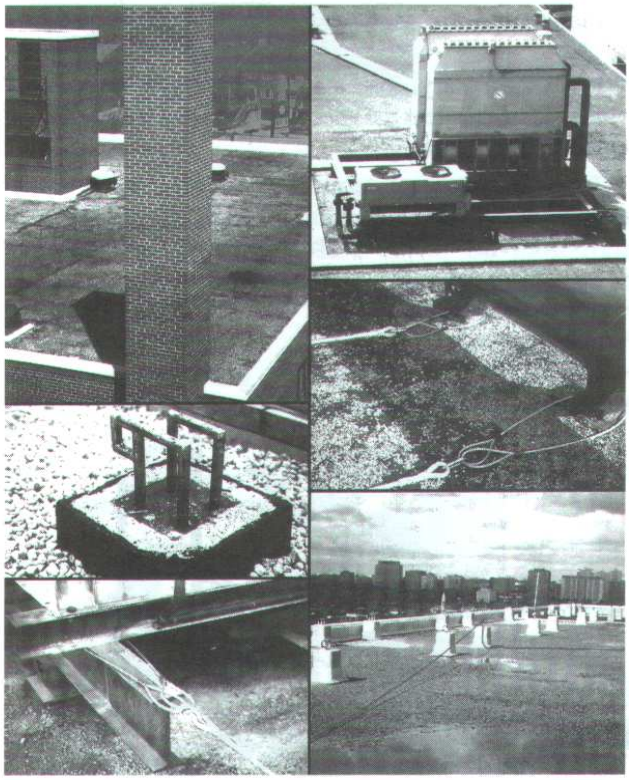
Chemicals – Chemical exposure can burn or degrade a lifeline very quickly. Ensure that material being considered for lifelines will resist any chemicals encountered on the job.

Storage – Always store lifelines separately. Never store them where they may contact hazards such as sharp objects, chemicals, or gasoline.

Anchor Systems

There are three basic types of anchor systems for fall protection:

1) designed fixed support – load-rated anchors specifically designed and permanently installed for fall protection purposes as an integral part of the building or structure (for example, roof anchors on high-rise buildings)
2) temporary fixed support – anchor systems designed to be connected to the structure using specific installation instructions (for example, nail-on anchors used by shinglers)
3) existing structural features or equipment not intended as anchor points but verified by a professional engineer or competent person as having adequate capacity to serve as anchor points (for example, rooftop mechanical rooms, structural steel, or reinforced concrete columns).



Examples of adequate anchorage

Designed fixed support can be used to anchor a fall-arrest system, fall-restricting system, or travel-restraint system if the support has been installed according to the *Building Code* and is safe and practical to use.

Temporary fixed support can be used as anchorage if it meets the following conditions:

- ✓ it can support at least 8 kilonewtons (1800 pounds) without exceeding the allowable unit stress for each material used;
- ✓ when used with a fall-arrest system incorporating a shock absorber, it can support at least 6 kilonewtons (1350 pounds) without exceeding the allowable unit stress for each material used; or
- ✓ when used with a travel-restraint system, it can support at least 2 kilonewtons (450 pounds) without exceeding the allowable unit stress for each material used.

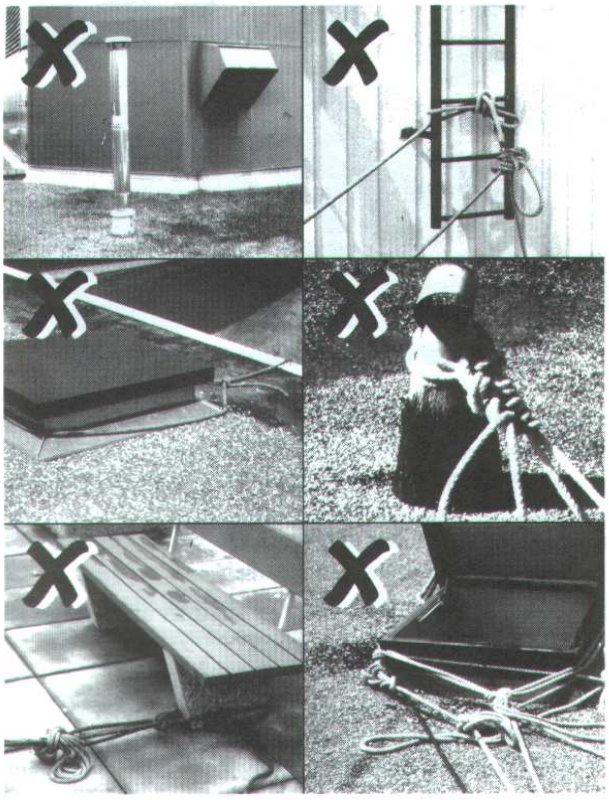
In all cases, a safety factor of at least two should be applied when determining the minimum load that an anchor point must support.

As a general rule with fall-arrest systems, choose an anchor capable of supporting the weight of a small car (about 3600 pounds).

When existing structural features or equipment are used as anchor points, avoid corners or edges that could cut, chafe, or abrade fall protection components.

Where necessary, use softeners such as wood blocking to protect connecting devices, lifelines, or lanyards from damage.

Never anchor to
- roof vents or stink pipes
- roof hatches
- small pipes and ducts
- metal chimneys
- TV antennas
- stair or balcony railings.



Examples of inadequate anchorage

Full Body Harness

- Chest strap should be adjusted so that it's snug and located near the middle of the chest. In a headfirst fall a properly adjusted chest strap will prevent the worker from coming out of the harness.
- Leg straps should be adjusted so the user's fist can fit snugly between strap and leg.
- Harness straps should be adjusted to put the D-ring between the shoulder blades. A properly positioned D-ring will keep a worker upright after fall arrest.

Inspect harness for
- ✓ burns, cuts, or signs of chemical damage
- ✓ loose or broken stitching
- ✓ frayed web material
- ✓ D-ring and keeper pads free from distortion and signs of undue wear or damage
- ✓ grommets and buckles free of damage, distortion, or sharp edges.

Lanyards

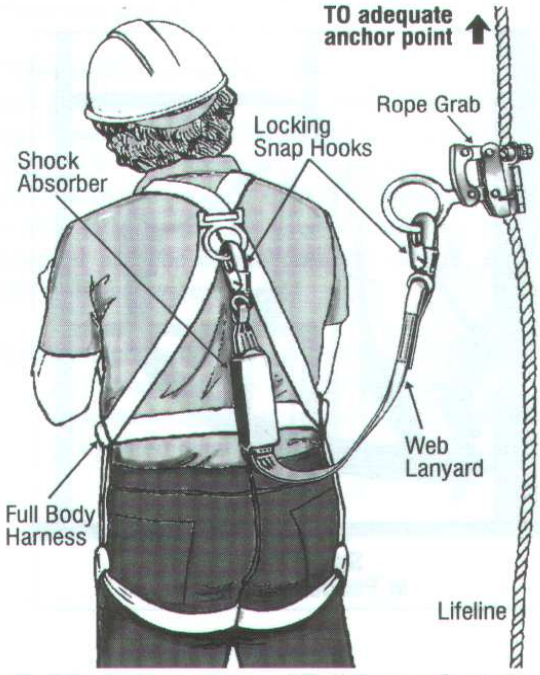
- Use manufactured lanyards only. They can be made of wire rope, synthetic fibre rope, or synthetic webbing.
- Lanyards are manufactured to specific lengths. Never try to shorten a lanyard by tying knots in it. Knots can seriously reduce its rated strength.
- Never store lanyards around chemicals, sharp objects, or in wet places. Never leave them exposed for long periods to direct sunlight.
- Inspect lanyards for
  - ✓ burns, cuts, or signs of chemical damage
  - ✓ loose or broken stitching
  - ✓ frayed web material.

Shock Absorbers

- Shock absorbers absorb some of the force generated by fall arrest. Shock absorbers can be purchased as separate equipment or built into lanyards.
- One end of the shock absorber ***must*** be connected to the D-ring on the full body harness.
- In most cases the shock-absorbing component is

enclosed in a snug-fitting jacket to protect it from the user's day-to-day activities. In a fall, the jacket tears open as the shock absorber deploys.

- Check the cover jacket for stress or tearing (many shock absorbers have a tag on the jacket that tears if the unit is exposed to a shock load—make sure this tag is intact).
- Ensure that a shock absorber built into a lanyard has a constant cross section or diameter.



Full Body Harness and Fall Arrest System

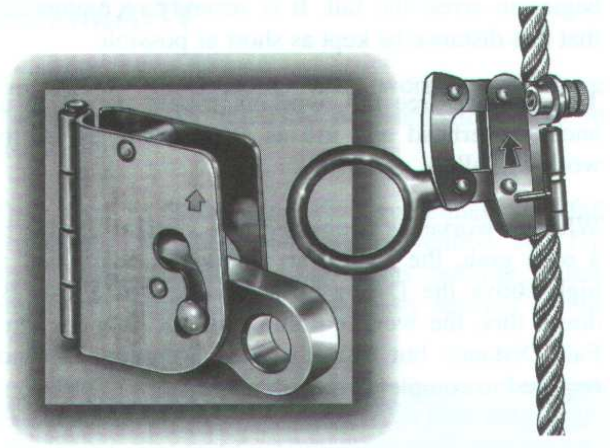
Connecting Devices

Locking Snap Hook – has a spring-loaded keeper across the opening of the hook that cannot be opened unless the locking mechanism is depressed.

Karabiner (D-Clip) – designed not to open under twist loads. To open the gate or keeper requires two separate actions: 1) twisting the locking mechanism and (2) pulling the locking mechanism back. When released, the spring-loaded locking mechanism flicks back into the locked position.

Rope Grab – used to connect lanyard to lifeline. These devices can be moved up and down the lifeline when a steady force is applied but will lock when a sharp tug or pull is applied. They will remain locked on the lifeline until the applied force is released.

Each rope grab is designed and manufactured for use with a specific diameter and type of lifeline. Specifications are usually listed on the housing.



Rope grab and lifeline must be compatible. The rope grab must also be attached to the lifeline in the correct direction—not upside down. On most rope grabs an arrow indicates the direction in which to orient the device.

Check all connecting devices for

- ✓ damage, cracking, dents, bends, or signs of deformation
- ✓ connecting rings centred—not bent to one side or otherwise deformed
- ✓ rust
- ✓ moving parts working smoothly
- ✓ signs of wear or metal fatigue.

Fall-Arrest Planning

Before deciding on a fall-arrest system, assess the hazards a worker may be exposed to in case of a fall.

Before the fall is arrested, will the worker "bottom out," that is, hit ground, material, equipment, or a lower level of the structure? Will the pendulum effect cause the worker to swing from side to side, possibly striking equipment, material, or structure? In the event of fall arrest, how will the suspended worker be rescued? Planning must take into account these and other concerns.

Total Fall Distance is the distance required to fully arrest a fall. It consists of

- Free Fall Distance, which should be kept to 1.5 metres (5 feet) or less, plus
- Fall Stopping Distance, which includes stretch in the lanyard (minimal), slack in the harness (maximum 30 cm or 1 foot due to allowable adjustments for user's comfort), and deployment of the shock absorber (maximum 1.1 metres—or 42 inches).

Free Fall Distance is measured from the D-ring of a worker standing on the work surface down to the point where either the lanyard or the shock absorber

begins to arrest the fall. It is strongly recommended that this distance be kept as short as possible.

To minimize free fall, workers should tie off to an anchor overhead and use as short a lanyard as the work will allow.

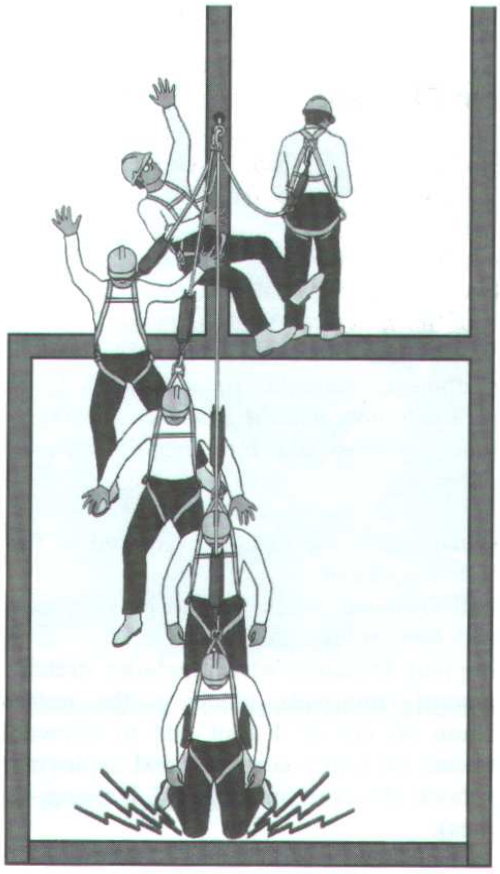
Where a worker is connected to a vertical lifeline by a rope grab, the rope grab should be positioned as high above the D-ring as the work will allow. By doing this, the worker minimizes not only the Free Fall Distance but also the Fall Stopping Distance required to completely arrest a fall.

Bottoming Out

Bottoming out occurs when a falling worker hits a lower level, the ground, or some other hazard before the fall is fully arrested.

This occurs when Total Fall Distance is greater than the distance from the work surface to the next level, the ground, or some other hazard below.

Fall-arrest systems must be planned, designed, and installed to prevent any risk of bottoming out.

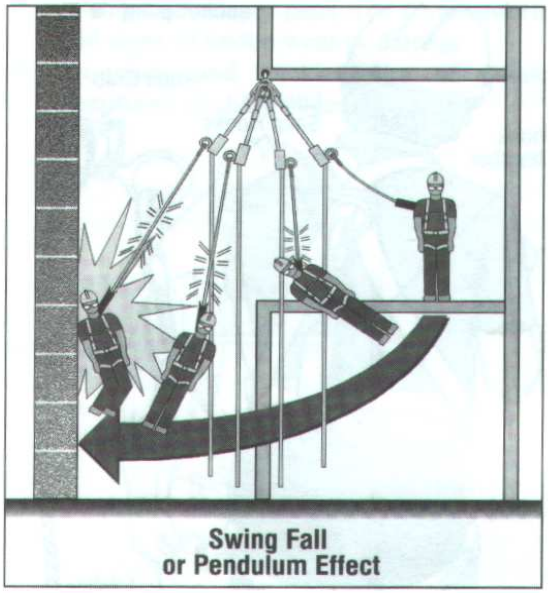


Bottoming Out

Pendulum Effect

The farther you move sideways from your anchor point, the greater the chance of swinging if you fall. This is known as the "pendulum effect." And the more you swing, the greater the force with which you'll strike columns, walls, frames, or other objects in your path.

Swinging may even cause your taut lanyard or lifeline to break where it runs over rough or sharp edges.



Swing Fall or Pendulum Effect

To minimize pendulum effect, workers should keep lanyard or lifeline perpendicular from edge to anchor. Where work extends along an open edge, anchor points can be changed to keep lanyard or lifeline perpendicular as work progresses.

Another solution is to run a horizontal lifeline parallel to the edge. The worker attaches lanyard to lifeline, moves along the edge, and the lanyard travels at the same pace, remaining close to perpendicular at all times.

Emergency Rescue

The construction regulation (O.Reg. 213/91) requires that before workers use any fall-arrest system or safety net on a project, the employer must develop written rescue procedures. It's important that a worker involved in a fall arrest be brought to a safe area as quickly as possible without causing injury or putting rescuers at risk.

In many cases, the rescue plan can be simple. A ladder or elevating work platform can be used to reach suspended workers and get them down safely.

Other workers may be hauled back up to the level from which they fell or pulled in through a nearby window or other opening.

In other cases, procedures may be more complicated. For instance, workers trapped on a failed swingstage, or hanging from it, may need to be rescued by specially trained and equipped personnel from the local fire department. Aerial ladder trucks or other high-reach equipment may be necessary. In extreme cases, the fire department may use rappelling techniques to reach trapped workers and lift or lower them to a safe level.

Plans should cover the on-site equipment, personnel, and procedures for different types of rescue. Any off-site rescue services that might be required should be contacted and arranged in advance to familiarize them with the project. CSAO's *Emergency Response* poster (P103) can be used to indicate the nearest hospital and the phone numbers of fire, ambulance, and police services.

Site management must ensure that
- everyone on site is aware of the rescue plan
- equipment and other resources are available
- designated personnel are properly trained.

SUMMARY

Employers, supervisors, and workers all have responsibilities in reducing or eliminating falls in construction.

This ***User's Guide*** provides guidelines for fall protection, including both fall prevention and fall arrest. But the information means nothing unless employers, supervisors, and workers apply it on the job.

Workers must receive training from their employer regarding the specific fall protection equipment and procedures they will use. Products differ not only between manufacturers but also between product lines in a single company. Training must therefore cover the exact harness, lanyard, shock absorber, rope grab, lifeline, and anchorage each worker will rely on, as well as the applications to be encountered.

If you have any questions about fall hazards or fall protection, ask your supervisor. When it comes to fall protection, make sure you know how the equipment works and how to use it. Your life depends on it.

Construction Safety Association of Ontario
21 Voyager Court South, Etobicoke, Ontario, M9W 5M7
416-674-2726 1-800-781-2726 Fax 416-674-8866
www.csao.org info@csao.org